SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 21, 1908

CONTENTS

Chemical Publications in America in Relation to Chemical Industry: PROFESSOR W. A. NOYES 225

The Theory of the Parasitic Control of Insect Pests: PROFESSOR C. W. WOODWORTH. 227

An Astronomical Expedition to Argentina... 230

Scientific Notes and News 231

University and Educational News 233

Discussion and Correspondence:—
The Chemical Formula of the Mineral Benitoite: W. C. BLASDALE. *Appointments in American Universities:* PROFESSOR R. M. WENLEY 233

Scientific Books:—
Musée Ostéologique: W. K. GREGORY. *Le-Renard's Essai sur la Valeur Antitoxique de l'Aliment Complet et Incomplet:* HOWARD S. REED. *Noyes's Organic Chemistry:* PROFESSOR GEO. B. FRANKFORTER .. 234

Scientific Journals and Articles 239

Types of American Grasses: DR. N. L. BRITTON 239

Dr. John B. Trask, a Pioneer of Science on the West Coast: DR. ROBERT E. C. STEARNS 240

Special Articles:—
The Grading of Students: PROFESSOR MAX MEYER. *A New Color Variety of the Guinea Pig:* PROFESSOR W. E. CASTLE. *The Origin of Varieties in Domesticated Species:* W. J. SPILLMAN..... 243

The American Association for the Advancement of Science:—
Section B—Physics: PROFESSOR A. D. COLE. 254

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y., or during the present summer to Wood's Hole, Mass.

CHEMICAL PUBLICATIONS IN AMERICA IN RELATION TO CHEMICAL INDUSTRY[1]

THE American Chemical Society holds a unique place among the chemical societies of the world. It combines functions and activities which could, heretofore, be found only in separate organizations. It is the only large chemical society in the world which includes both those who are engaged in the application of chemistry to the industries and to chemical engineering and those who are engaged in teaching and in researches with no immediate practical bearing and which provides adequately for the interests of all classes of chemists. There are two reasons which justify this policy. In these days of intense specialization one of the greatest dangers to a professional man is that he will become so intensely absorbed in the field in which he is working that he loses all interest in other lines of work and falls out of touch with the rapid advances which his science is making in every direction. This tendency is almost as marked and fully as dangerous for those who are engaged in pure research as for those working in applied chemistry. Both classes of our members find that contact with chemists having a radically different point of view is exceedingly stimulating and useful. The advantages of an Abstract Journal which covers both fields are so self-evident as scarcely to require remark.

The second reason which justifies the

[1] An address delivered at the New Haven meeting of the American Chemical Society, July 2, 1908.

union of all classes of chemists in a single society is that only in this way is it possible to provide at moderate expense those publications which are needed by every chemist. The chemists of the world seem to have realized only very dimly the advantages in economy which result from combination for purposes of publication. The fundamental principle is that for a small circulation the original cost of gathering the material and setting the type forms a large proportion of the total cost of publication. After the matter has once been accumulated and printed the cost of printing and distributing additional copies is relatively small.

The German Chemical Society, when it began to publish, officially, the *Chemisches Zentralblatt*, adopted the plan that the journal was to be sent only to those who will pay for it. The result is that those who take the *Zentralblatt* must pay nine dollars a year for it in addition to the dues of the society and the journal goes to about one half of the members. The total circulation of the *Zentralblatt* is only about 2,000. The American Chemical Society in establishing *Chemical Abstracts* has adopted a different plan. While it was recognized that a few of our members might not care for the journal, it was seen that by increasing the dues of all the members it could be sent to all at a comparatively moderate expense. Accordingly, the dues were increased by three dollars for all members. While *Chemical Abstracts* costs, at present, between five and six dollars per member, it is securing such support among the chemists of America and of the world that the permanent success of the enterprise seems to be assured. In adopting the budget for 1907 the council considered that if enough new members were gained during the first year to make up for those who fell out on account of the increase of dues we should do well. Instead of that the society had a net gain of 310 members. When *Chemical Abstracts* was started in January, 1907, we had a membership of 3,079. We now have 3,800 members.

In establishing *Chemical Abstracts* it was recognized that the funds available would not permit of the publication of as large a journal as the *Chemisches Zentralblatt*. It has, however, approached much more nearly to the size of that journal than was anticipated and, while the abstracts in some divisions are relatively brief, it may be fairly said that *Chemical Abstracts* covers the whole field of chemistry better than any other similar publication. To illustrate, *Chemical Abstracts* gives abstracts of American, English, German and French patents, while the *Zentralblatt* gives abstracts of German patents only. The number of abstracts in biological, mineralogical and geological chemistry greatly exceeds the number in the same lines in the *Zentralblatt* and the same is true of all lines of technical chemistry. The total number of abstracts, even in the first year of publication, is also greater in *Chemical Abstracts*, although the total number of pages is less.

The fields covered by *Chemical Abstracts* are so varied that at the low subscription price of six dollars a year it should secure many subscribers among persons whose primary interest is in other sciences than chemistry. Physicians and biologists will find much that is of value to them under biological and pharmaceutical chemistry, physicists will be interested in physical chemistry, radioactivity and electrochemistry and geologists in mineralogical and geological chemistry.

As an almost necessary result of what has been stated about publication, the American Chemical Society has accepted the principle that it can afford to extend the benefits of its membership to any one

who is willing to pay the dues. The statement has recently been made that this has resulted in a membership which is largely non-professional. Such a statement is wholly misleading. While the fact that a man is a member of the society is no guarantee that he is a trained chemist, there are very few members who are not engaged in chemical work and I think I am safe in saying that ninety per cent. of the members have had a good chemical training.

The American Chemical Society is about to establish a *Journal of Industrial and Engineering Chemistry*. This journal, too, is to be sent to all members of the society. The objection has been raised that it should be sent only to those members who are especially interested in it. Such a course does not seem wise for two reasons. First, in accordance with the ideal of the society, which is to care adequately for the needs of all classes of chemists, we wish to continue to furnish all of our members with original papers as well as with abstracts in all fields of chemistry. Second, if we were to adopt the other plan, we could afford to give as a rebate to any one who does not care for the journal only the amount which would be saved by printing a smaller number of copies. This amount is so small as to be scarcely an object. We seem to be justified, therefore, in adopting for the *Industrial Journal* the same plan which has met with so much success in the case of *Chemical Abstracts*.

We already have some members in nearly every civilized country in the world—in England, Germany, South Africa, Australia, New Zealand, China, Japan, Chili, Brazil, Argentina and many others.

The broad policies which have been adopted by our society can succeed only on the basis of a very large membership. We need the loyal support of every American chemist.

W. A. NOYES

THE THEORY OF THE PARASITIC CONTROL OF INSECT PESTS

ALL who have recently discussed the question of the possibility of controlling insect pests by the use of parasitic or predaceous insects or by fungous or bacterial diseases, have failed to consider the subject from a very important point of view.

The conditions determining the life or death of insects are much more complicated than is usually appreciated, and the individual factors in the problem are far from independent. The correct estimation of this interdependence of the causes of death in insects is of vital importance in this connection. The efficiency of each factor is so influenced by the efficiency of the others that the elimination of one cause of death or the addition of an entirely new natural enemy will usually have but a slight effect upon the rate of survival or none at all.

The reproductive powers of most organic beings are very great. Were not all creatures liable to die prematurely, that is, before they reproduced themselves, reproduction would of necessity have been limited to two offspring from each pair. Whenever reproduction is at a more rapid rate it is a *prima facie* evidence that the chance of premature destruction requires it and the greater the reproductive power the higher this normal death rate. Were conditions otherwise, rapid extinction or enormous increase would result. The fact that species maintain themselves for ages with the ratio between the birth rate and that of premature death not varying an appreciated fraction of a per cent. is very evident.

This balance between birth- and death-rates is much greater than the numerical stability. For instance, in the case of a species increasing a hundred fold in a generation, an average disturbance of only a

hundredth part of a per cent. in this ratio —*i. e.*, if on the average one more individual in ten thousand should come to maturity—this would result in nearly tripling the numbers of individuals within a hundred generations, and one tenth of one per cent. augmentation—*i. e.*, if one more in a thousand should survive—would be an increase in numbers amounting in the same period to nearly fourteen thousand fold.

DISTURBING, CONTRIBUTING AND EFFECTIVE FACTORS

The various causes of death may be classed into two groups; first, those that destroy all insects in a certain condition or position, irrespective of the numbers present (for instance, frost, which might kill the same proportion whether there was but one to the acre or a hundred thousand); and second, those that are more and more efficient as the numbers increase. This is true in general of predaceous and parasitic insects and of diseases. Causes of death of the first class will aid in maintaining the balance in an insect to the extent they are uniform in their action, the regularly recurring winter, for instance; but are usually erratic and disturbing rather than balancing. Those of the second category, however, all tend towards balance and their efficiency is attested by the approximate balance maintained in nature. Probably in all cases numerous parasites and predators and other factors of this same class contribute to form the controlling environment of an injurious species, and each factor has a different potentiality. Those of the second category can be further subdivided into two classes, the contributory and the effective. In the former class, the efficiency increases with the increase of the host, but not in a sufficient ratio to ever overtake it. Thus with the host at one hundred per acre it may destroy one third, at two hundred four ninths, at four hundred thirteen twenty-sevenths, etc., never reaching fifty per cent. Any series that does not ultimately pass the percentage of normal death rate is incapable of itself diminishing the numbers of its host. Its only effect is in slowing down the rate of increase until some effective factor becomes operative or until a disturbing factor like frost produces a general destruction.

The effective class of factors is that in which the ratio finally reaches one hundred per cent. Thus with the host at one hundred per acre it may destroy say one half, at two hundred three quarters, at four hundred, seven eighths, etc.; finally reaching a fraction so large that only those survive that are necessary to maintain the species.

Every factor of this class has its particular point of balance. One may overtake the host at two hundred per acre and another only at two million per acre, but both be finally efficient. To a member of this class of checking factors, Mr. Elwood Cooper, the former Horticultural Commissioner of California, would apply the term "the true parasite," and those alone he would consider worthy of importation.

To determine at any time the status of an insect we should have to know the percentage of efficiency of each factor under the existing numerical prominence of the host and in order to prognosticate the future we should need to know the ratio of increased or decreased efficiency of each under the changed numbers of the host.

None of these factors can ever be determined with any great degree of accuracy because they are each involved in as complicated a system of interrelations and in many cases the efficiency of a check against any one insect is profoundly influenced by the ups and downs of numerous other insects that serve as alternate hosts.

The complication of the subject indeed is

so great that accuracy even of observation will be impossible, but the failure to reckon with all the factors of the problem will make conclusions of little significance.

The interrelation of factors may be of the most complicated nature; for instance, a parasite which of itself might be wholly inefficient due to its slow rate of reproduction as compared with that of its host, might be rendered very efficient by the cooperation of a contributing factor which could only delay the rate of increase.

It will be thus readily seen that the efficiency of all these factors working together is neither the sum nor the average of the potential efficiency of each, though much nearer the latter than the former. Many writers have assumed that by adding a new parasite, its efficiency was simply added to that of others previously existing. This supposition is certainly far from the theoretical conception of the interrelations of species as presented above, and has not been borne out in actual experience.

RELATION OF LIFE CYCLE OF HOST

Thus far the insect whose control is sought is conceived of as existing in but one condition. The growth and transformation of insects add still further complications to the subject. The checks are not simultaneous in their action, but at each stage in the progress of its development the insect lives in a different environment. The parasites, for instance, that affect the egg will find the next generation of eggs perhaps more profoundly influenced by the checks that have operated during the remainder of the life of the insect than anything they have accomplished, and so perhaps with the checks operating at any stage. A serious attack of one parasite during early larval life might result in protecting the insect from still more efficient destroyers in the late larval stage and really cause more to come to maturity.

SUGGESTIONS FOR LABORATORY STUDY

We can eliminate most causes of death under artificial breeding conditions and often produce one hundred per cent. of survival. When this can be done we are in a position to begin the experiment of testing first one at a time each cause of death, then to study their interrelations or the simultaneous or alternating effects of two of these factors, in the case of parasites studying as thoroughly in detail also their environment. Until considerable work of this kind is done the basis for our theories will not have been well enough established to deserve a place as science.

ECONOMIC RELATIONS

The power of an insect to do damage is due as a rule to the number present during their chief feeding period, and may be quite independent of the numbers that finally come to maturity, and is absolutely independent of the ratio between birth and death rates. A temporary disturbance of this rate produces increase or decrease and may place an insect suddenly in the destructive class or remove it, but while an insect maintains itself in injurious numbers the ratio is as low as though the insect were rare.

In the case of most of our injurious insects the natural increase is more than a hundred fold, so that less than one per cent. is in these cases the established average rate of survival. This is true even of such recently introduced pests as the gypsy and brown tail moths, and the boll weevil, everywhere, except when the conditions are temporarily disturbed by efforts at control and along the border of the infested area where the insects are invading new territory.[1]

[1] This invasion of new territory probably involves but a narrow strip. In the case of the

This being the case it will be evident that the effective portion of the work of any introduced parasite lies within the fraction of one per cent. that would otherwise survive. It therefore follows that should an insect be introduced that would destroy fifty per cent. of the pest, more than forty-nine per cent. of this fifty per cent. is simply the destruction of individuals that would have died from other causes. The real question to be settled therefore becomes whether the new insect replaces a more or a less efficient cause of death. The apparent per cent. of efficiency is really no criterion whatever of the value of the introduction. That which we are desiring to secure is the reduction of the numbers especially during the period of injury, and therefore the only significant datum is the determination of the relative abundance maintained by the injurious species. The numbers of any particular parasite is not even a safe index of its rôle in the maintenance of this status, unless one were able to accurately weigh its efficiency as contrasted with that which it replaced.

All entomologists appreciate that natural enemies are largely if not the only controlling factors that maintain the present status of insect abundance, but do not so uniformly appreciate that the change of status though related is nevertheless essentially a different problem.

C. W. Woodworth
University of California

AN ASTRONOMICAL EXPEDITION TO ARGENTINA

The Department of Meridian Astrometry of the Carnegie Institution, in charge of Professor Lewis Boss of the Dudley Ob-

boll weevil the extreme annual migration is about the width of two counties. The total extension of this insect into new territory only requires an average survival of about two per cent. in the outer two tiers of counties.

servatory at Albany, N. Y., where the work of the department is carried on, is dispatching an expedition to the Argentine Republic to establish a branch observatory there. This observatory will be established at San Luis about 500 miles west from Buenos Aires. This town of about 10,000 inhabitants is located near the eastern edge of the Andean plateau at an elevation of about 2,500 feet. It is reported to have a fine climate with remarkably clear skies.

The new observing station consists of the necessary observing structures, and temporary barracks for office rooms and quarters for the staff. The principal instrument will be the Olcott Meridian Circle of the Dudley Observatory. This instrument will be set up in its new location for the purpose of making reciprocal observations upon stars already observed at Albany, together with observations upon all stars from south declination to the south pole that are brighter than the seventh magnitude, or which are included in Lacaille's extensive survey of the southern stars made at the Cape of Good Hope in 1750. It is thought that this new scheme of making reciprocal observations on the same stars, with the same instrument, alternately used in the two hemispheres will present peculiar advantages in point of accuracy in the systematic sense. To reach this accuracy has long been the problem of fundamental work in astronomy. It is estimated that the work of observation in Argentina will last three or four years.

The object of these observations is to gather material for facilitating the construction of a general catalogue of about 25,000 stars, in which will be contained accurately computed positions and motions of all the stars included in it.

The department has already completed for publication a general catalogue of 6,188 stars, including all the most accurately ob-

served stars and all from the North to the South pole of the heavens that are visible to the naked eye. This work has already resulted in interesting conclusions in reference to star-streams, the solar motion in space, and other stellar problems.

The preliminary expedition to establish the new observing station sailed from Brooklyn for Buenos Aires, August 20, on the steamship Velasquez. Accompanying Professor Boss, is Professor Richard H. Tucker, of the Lick Observatory, well known for his work in observation with the Meridian Circle of the Lick Observatory. He will superintend the construction of piers and buildings for the new observatory, and he will be placed in charge of the observations after the station shall be ready for operation. Mr. Varnum, for many years an assistant at the Dudley Observatory, is also a member of the party. Later on the remainder of the staff, which in all will consist of eight persons, will be sent to the new observatory when it shall be ready for work.

This undertaking has met with cordial recognition from Mr. Epifanio Protela, Argentine minister to the United States, and from other representatives of the Argentine Government, which in the most liberal and enlightened spirit has extended every assistance and courtesy.

SCIENTIFIC NOTES AND NEWS

PROFESSOR C. O. WHITMAN, head of the Department of Zoology in the University of Chicago, has resigned the directorship of the Marine Biological Laboratory, Wood's Hole, Mass., which he has held for the past twenty years. Professor Frank R. Lillie, of the University of Chicago, the assistant director, has been elected to the directorship.

AT the meeting of the French Association for the Advancement of Science at Clermont Ferrand, the gold medal of the association was presented to Sir William Ramsay.

IN connection with the Sheffield meeting of the British Medical Association, the faculty of science of the University of Sheffield has conferred honorary degrees as follows: President-elect, Professor Simeon Snell; Dr. Henry Davy, of Exeter, the outgoing president; Professor Bouchard, of the University of Paris; Professor John Chiene, professor of surgery at Edinburgh; Dr. Kingston Fowler, dean of the medical faculty of the University of London; Professor Fuchs, the Viennese ophthalmologist; Professor Lucas-Championnière; Dr. C. J. Martin, director of the Lister Institute; Professor John Murphy, of Chicago; Dr. Thomas Oliver, known for his work on dangerous trades; Mr. Edmund Owen; Sir Henry Swanzy, of Dublin; Professor Tillmanns, of Leipzig; and Dr. Dawson Williams, editor of *The British Medical Journal*.

The Journal of the American Medical Association states that a banquet in honor of the seventieth birthday anniversary of Gen. George M. Sternberg was given on June 8, when nearly 200 men celebrated in the annals of government, science and literature met to honor the former surgeon-general. The Hon. John W. Foster, formerly secretary of state, presided as toastmaster. A silver loving cup was presented to General Sternberg by those who attended the banquet, and a large American flag was given him by the attachés and patients of the Sternberg Sanitarium in Maryland.

M. GAILLOT has been elected a corresponding member of the Paris Academy of Sciences in the section of astronomy, in the room of M. Trepiéd.

THE president of the Republic of France has conferred upon Professor Wm. B. Alwood, of Charlottesville, Va., the Cross of Officier du Mèrite Agricole, and the Société Nationale d'Agriculture de France, has awarded him the silver medal and diploma of the society.

DR. JAMES A. NELSON, formerly honorary fellow in entomology and invertebrate zoology at Cornell University, has accepted an appointment with the Bureau of Entomology at Washington, D. C. Dr. Nelson who is a graduate of Kenyon College and received his

Ph.D. at the University of Pennsylvania, will be occupied with certain problems in insect embryology.

Dr. Gustav Melander succeeds Dr. Ernst Biese as director of the Finnish Central Meteorological Station.

Dr. F. Ristenpart, of Berlin, has been appointed director of the Observatory of Santiago de Chile, as successor to Dr. A. Obrecht.

We learn from *The Auk* that Mr. Robert Ridgway has returned from his trip to Costa Rica. Although his visit was not as prolonged as originally intended, Mr. Ridgway succeeded, with the cooperation of his friends, in collecting over 900 birds, besides other material. His collecting stations were chiefly Escasú, at the base of the Cerro de la Candelaria; Guayabo, at the eastern base of the Volcan Turrialba; also at an altitude of over 9,000 feet on the volcano itself; and at Bonilla, east of Guayabo.

The assistants of Professor Novarro, of Genoa, have decided to endow a prize to be called by his name and awarded for work in general pathology. Professor Novarro's election to the Italian senate was the occasion of the movement.

At the recent meeting of the British Medical Association the Stewart prize was awarded to Colonel Sir David Bruce, F.R.S., for his researches as to the origin and prevention of Mediterranean fever and the Middlemore prize to Profesor Simeon Snell for his contributions to the science of ophthalmology.

The death is announced of Edward Augustus Samuels, the author of an "Ornithology and Zoology of New England."

Sir Thomas Stevenson, senior scientific analyst to the home office of the British government, died on August 7, at the age of seventy years.

Prince Yamashima, who made valuable contributions to Japanese meteorology and seismology, has died at the age of thirty-one years.

The deaths are also announced of Professor J. V. Barbosa du Bocage, director of the Zoological Institute, at Lisbon, at the age of eighty-four years; of Dr. Hermann Karston, the botanist, at Berlin, at the age of ninety-two years, and of Professor Daguillon, assistant professor of botany at the Sorbonne.

The New York Academy of Medicine announces that the sum of $1,000 will be awarded to the best essay in competition on "The Etiology, Pathology and Treatment of the Diseases of the Kidney." Essays must be presented on or before October 1, 1909.

By the will of Mrs. A. L. R. Waldo-Sibthorp, bequests are made to the Royal Hospital for Incurables and the Charing Cross Hospital, respectively, of £20,000 and £10,000, and the residue of the estate, estimated at some £75,000, is bequeathed to the West End Hospital for Diseases of the Nervous System.

According to the *Journal of the American Medical Association,* the Swedish Medical Association is to celebrate its centennial next October, at Stockholm. A special committee is making great efforts to have a notable collection of historical medical portraits, medals, printed and manuscript works and an antique apothecary shop as features of the celebration. The committee includes some of the editors of *Hygiea,* the official organ of the Swedish Medical Association, which issues an appeal for all to bring forth their historical relics, etc.

The meeting of Imperial and Colonial Meteorologists has been postponed until next year at the time of the British Association for the Advancement of Science meeting in Winnipeg. The postponement is due to the fact that many English meteorologists whom it is desirable should attend, wish to be present at the Winnipeg meeting and do not care to visit Canada this year.

We learn from *The Observatory* that the commonwealth government of Australasia has taken over the meteorological services of all the Australian States.

The same journal states that efforts are being made to establish a solar observatory in Australia, and in particular at Adelaide. The Melbourne, Sydney and Perth Observatories are busy with the Astrographic Catalogue, so

that three of the Australian colonies are scarcely in a position to undertake this new work; but South Australia is freer, and if it can establish a solar observatory, either at Adelaide or elswhere, a gap in longitude will be satisfactorily filled. The scheme is receiving substantial private support. In addition to the promise of a telescope (a 6-in. Grubb equatorial refractor) from the trustees of the estate of the late Lord Farnham, Dr. W. Geoffrey Duffield, of the Physical Laboratories, Manchester University, has received from Mr. Frank K. McClean the offer of £500 towards the purchase of a large spectroheliograph, on condition that an additional sum of £1000 be privately subscribed towards the same piece of apparatus.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Toronto is conducting a course in hygiene of twenty lectures. Dean Reeve of the medical faculty will take up the eye and ear; Dr. George R. McDonagh, the nose and throat; Dr. Charles Sheard, contagious and infectious diseases; Dr. Abbott, color blindness, and Dr. William Oldright, general sanitation.

DR. CHAS. C. ADAMS, of the University of Chicago, has been appointed associate in animal ecology at the University of Illinois.

IN the faculty of engineering at University College, London, a new lectureship in electrical design has been instituted, to which Mr. Henry Metcalf Hobart has been appointed.

MR. W. JACKSON POPE, F.R.S., professor of chemistry in the University of Manchester, has been elected into the professorship of chemistry, at Cambridge, rendered vacant by the resignation of Professor G. D. Liveing, who has held the chair since 1861. Mr. Pope, who was born in London in 1870, was educated at Finsbury Technical College and the Central Technical College, London. Before going to Manchester he was head of the chemistry department of the Goldsmiths' Institute, London.

DR. HANS SPEMAN, of the University of Würzburg, has been appointed professor of zoology at the University of Rostock.

DISCUSSION AND CORRESPONDENCE

THE CHEMICAL FORMULA OF THE MINERAL BENITOITE

IN a recent issue of SCIENCE (May 1, 1908) Mr. Edward H. Kraus discusses the recently described mineral benitoite, and suggests a formula which differs somewhat from the one proposed by Professor Louderback in his original paper. The two analyses already reported, and a third which will be published shortly, all show that the empirical formula of the mineral is $BaTiSi_3O_9$ and the most reasonable assumption is that it is made up of the three oxides BaO, TiO_2 and SiO_2. Mr. Louderback's proposal is that the mineral is a very acid titano-silicate of barium, whereas Mr. Kraus suggests that the titanium here plays the part of a base and that therefore the mineral is a double metasilicate of barium and titanium. Though it must be admitted that absolute proof of the correctness of either of these two suggestions is at present scarcely possible it seems to me that the arguments advanced by Mr. Kraus are entirely unsatisfactory and I submit the following objections.

The main argument upon which Mr. Kraus bases his formula is the alleged isomorphism of benitoite with beryl, which mineral is usually regarded as a salt of metasilicic acid. If the most favorable values are chosen the ratios of the *a* axis to the *c* axis for the two minerals are 1.4989 and 1.4230, respectively. These figures show an actual difference of more than sixteen per cent. of the magnitude concerned, and even interpreting the law of isomorphism with that degree of looseness which is not uncommon among mineralogists, furnish no evidence upon which to base conclusions as to the molecular structure of the two compounds. The two minerals also differ widely as to form and habit; one is trigonal and the other holohedral. Further, many of the illustrations which Mr. Kraus cites as examples of isomorphism are open to serious question; galena and argentite most certainly can not be called isomorphous merely because they both crystallize in cubes.

The occurrence of benitoite in rock formations which are of a basic character, upon

which Mr. Kraus bases a second argument, is to my mind of no significance. The benitoite and the natrolite matrix in which it occurs are clearly secondary and must have been formed from percolating solutions. Even if it be assumed that these solutions were also basic it by no means follows that the titanium which they contained would take the part of a base, on the contrary it is more probable that it would take the part of an acid. Associated with the benitoite are two other titanium-containing minerals, namely, titanite and a mineral to which the name carlosite was given, but which we have since shown to be identical with neptunite. All three minerals are found in the natrolite matrix and appear to have been formed contemporaneously. There is good reason for supposing that titanium takes the part of a base in both titanite and neptunite and it is not probable that a third mineral formed under similar conditions would differ in this respect.

There is on the contrary much to be said in favor of the formula suggested by Mr. Louderback. The properties of the element titanium, when in this degree of oxidation, are clearly those of a very weak acid. The entire lack of a definite compound of titanium and silicon, in view of the frequent occurrence of both oxides in the same formation, is striking. If benitoite is a double metasilicate of barium and titanium it is most remarkable that the proper conditions for the formation of both its constituent single salts have nowhere prevailed.

A cursory examination of the literature shows that many of the compounds in which titanium is supposed to take the part of a base have not been isolated in pure form, nor has their structural formula been satisfactorily determined. They are in all probability analogous to certain complex acids, such as those which phosphoric acid forms with the acids of the chromium group of elements rather than to simple salts.

Titanium is more closely related to silicon than to the more basic zirconium. Like the former element it shows a decided tendency to combine with itself and form complex molecules, and the substitution of one element for the other in such a chain would not seem unreasonable. Further, there is nothing unreasonable in the formation of compounds containing such a relatively large percentage of acidic elements if the acidic elements represented are very weak in their properties and the basic elements are very strong in theirs; the compound borax furnishes a good illustration.

W. C. Blasdale
Department of Chemistry,
University of California

Appointments in American Universities

To the Editor of Science: As a Scot, called some years ago to teach in an American university, I am much interested in Dr. S. J. Meltzer's communication, printed in Science of August 7, especially as two of the gentlemen to whom he refers are countrymen of my own. However, my purpose is not to traverse his protest, which seems to me well taken. Dr. Meltzer's letter involves a much larger question. I think that those of us who have to make recommendations for vacancies must have felt often that here, at least, we stand badly in need of a clearing-house. Why should not each great department of inquiry have its own bureau of information, to bring men and places together? Our present methods are largely haphazard, especially with reference to the less important appointments, whence the more important must be filled some day. One hears of vacancies after they have been settled; and one's knowledge of available appointees, especially of the younger men, is far from complete. Here is an opportunity for Science and similar publications to ventilate a need, with a view to common action.

R. M. Wenley
University of Michigan

Scientific Books

Musée Ostéologique. Étude de la Faune Quaternaire. Ostéométrie des Mammifères. Par Edmond Hue Médecin Vétérinaire, Membre de la Société Préhistorique de France. Album de 186 planches contenant vi + 50, pl. 93. Deuxième Fascicule, pl. 2,187 figures. Premier Fascicule, pp.

94–186. Royal 8vo. Schleicher Frères, Éditeurs. Paris. 1907.

The existence in Europe of hundreds of Quaternary and prehistoric stations yielding copious remains of men and animals occasions the desire on the part of the archeologist to study for himself the bones which he may have exhumed from grotto or lake dwelling. Hitherto, in order to identify these remains he has had to take them to some museum having a large osteological collection, or to search through the literature for illustrations of particular groups, or to have recourse to the general works of Cuvier and of DeBlainville, which are not always accessible and which were designed rather for the morphologist than for the archeologist.

To facilitate the identification of such collections M. Hue has placed in the hands of the student this veritable "Musée Ostéologique" containing no less than 2,187 original figures of mammalian bones. The drawings have been very skillfully and accurately made from nature by the author himself, the mechanical form and the arrangement of the book are excellent, and the price (24 fr.) is moderate. Forty-one recent mammals are represented, including the principal types whose ancestors are found in the Quaternary of Europe. The work is divided into three parts. Part I. treats of osteometrical methods, Part II. figures the cranium and dentition, Part III. the limb bones.

In Part I. the author endeavors to put the osteometry of the mammalia upon a practical basis. Hitherto, he thinks, the measurements given in different works upon Quaternary mammals are too frequently unsatisfactory because each author has followed his own system of measurements. Owing to the fragmentary character of most Quaternary crania and limb bones, the important longitudinal and transverse diameters are often unattainable, and the effective comparison of any two similar fragments is limited by the number of exactly corresponding measurements given. Hence the justification for multiplying measurements and for the present effort to standardize the mensuration of the mammalian skeleton in general.

For this purpose the well-established measurements and ratios of physical anthropology are not sufficient. Measurements and ratios applicable to all mammals are needed, and, by reason of the divergence in type, additional standard measurements for each order.

Selecting the skull and lower jaws of the dog as a representative mammal, the author establishes, defines and illustrates (Pl. 1–7) a long series of paired points, between which measurements may be taken in normal mammalian skulls.

The author then takes up the different orders in turn and establishes similar paired points, which are especially characteristic in the Carnivora, Rodents, Ruminants, Equidæ and Suidæ. Standard measurements for the dental system are then established and the subject of cranial indices is discussed and illustrated. The mensuration of the limb bones and vertebræ is similarly treated (pp. 28–50, pl. 8–21).

In the third part (pl. 79–186) the limb bones are figured in the same systematic manner, the Ruminants again being very fully represented. As all the drawings of each part, *e. g.*, the humerus, are brought together, one can very quickly identify a specimen by glancing over a few plates. On the other hand, one can readily follow up the osteology of a single form by consulting the alphabetical table of species. The smaller crania and practically all the teeth are represented as of the natural size, the larger objects are always given in some convenient scale and centimeter scales are given in many of the plates.

The reviewer has gone over the plates with some care, but has not noticed any material errors, though it can scarcely be hoped that none are there. On the contrary, the many admirable features of the work become very apparent. For instance, the roots as well as the crowns of the teeth are represented, a feature more or less neglected even in the best odontographies. The grouping of the same part in different animals, and the representation of each object in orthogonal projection, bring out the underlying family resemblances and differences, accentuating diagnostic characters which would not be

noticed ordinarily except through long familiarity with the bones themselves.

M. Hue's drawings serve to emphasize the fact that the text-books of osteology and mammalogy have failed to make the most of the characters offered by the scapula, humerus, femur and other limb bones, although such characters are very important to the fossil bone hunter in the field, and also sometimes give indications of affinity between two forms whose skulls and dentition have become widely divergent. In this connection, in view of the sharp ordinal and family differences in the tarsus and especially the astragalus, it is rather curious that the author devotes so many plates to the tibia and fibula, which are usually less clearly distinctive, and yet only figures the tarsus of two forms, the dog and the reindeer.

In conclusion, M. Hue may be assured that his work will be of use not only to the archeologist, but also, and to a considerable degree, to the student of mammalian osteology. The work, of course, covers only a rather limited fauna, but its method and example are alike valuable. It would greatly widen the general intelligibility of osteology if the skeletal parts of all the more important genera of mammals, both living and fossil, could be represented in plates similar to those of M. Hue, but arranged historically, *i. e.*, according to the best views of their evolutional sequence. This would naturally be a large undertaking, but no bigger for the twentieth century than DeBlainville's Osteographie was for the first half of the nineteenth century.

William K. Gregory

Essai sur la Valeur Antitoxique de l'Aliment Complet et Incomplet. By A. LeRenard. Paris, J. Mersch. 1907. 8vo; pp. 211.

It is seldom that a work appears which has more interest for general physiology than the present one. Starting with a study of the toxic action of copper salts upon *Penicillium glaucum*, the author has incepted a series of illuminating experiments upon the ability of the different essential nutrient elements to function as antitoxic agents. The action of the various salts and ions was tested in all combinations possible, always in the presence of a suitable source of carbon.

While the idea of an antidoting action between elements is not new, it has never before been so extensively investigated as an antagonistic relation between foods and poisons.

The author presents a lengthy review of literature upon the general subject of toxicity and antidoting action, but unfortunately devotes little attention to the work which has been done since 1900. It is to be especially regretted that the discussion does not include the investigations upon the antidoting action of physiologically balanced solutions by Loew, Loeb, Osterhout, Duggar, Benecke and others.

The chapter on the general biology and physiology of *Penicillium glaucum* gathers up and coordinates much of the modern and early work upon this classical and oft-investigated fungus. The chapter upon the physiological rôle of the essential nutrients seems conspicuously brief in comparison with the treatment accorded other subjects of like importance. Nitrogen, potassium and phosphorus receive a brief elementary treatment; the other mineral elements are very briefly dismissed.

The author's extended discussion of the nature of toxicity contains numerous points of special interest for the student of physiology, a few of which deserve mention in passing. He emphasizes the necessity for distinguishing between injurious effects due to the osmotic strength of the solution and those actually due to poisons, especially since the former may be brought about by non-toxic substances.

Following the classification of Chassevant and Richet, which distinguishes between antigenetic and antibiotic concentrations of the toxic agent, LeRenard distinguishes the antiauxic and antibiotic concentrations of copper for *Penicillium glaucum*. The antiauxic concentration is defined as the one which allows the fungus spore to germinate and produce some sort of a germ tube, but does not allow the development of the same into a thallus. It is admitted that antiauxic effects may also be produced by a paucity of nutrients. By diminishing the amount of poison, a sufficiently weak concentration is finally reached

which will allow the fungus thallus to make a good growth, but prevent it from forming organs of fructification; this is the antigenetic concentration. The antibiotic concentration is one sufficient to kill an adolescent thallus; however, two sorts of antibiotic effects are exhibited by thallophytes when acted upon by poisons. (1) Before reaching the fatal concentration, a point is found at which the plant ceases to grow. This point is designated the partial antibiotic concentration, and may be represented by an action analogous to that of ether or chloroform, which deadens or suppresses some of the functions. (2) The total antibiotic concentration causes a sudden and complete termination of the vital functions.

In estimating the effect of toxic solutions in his investigation, LeRenard made use of a new standard. On account of the very dilute solutions sometimes used, the fungus could make but little growth and the usual criterion of dry weight was inapplicable. He, therefore, determined what was practically the antiauxic concentration in each case. This was determined by ascertaining the point at which the majority of spores became vacuolate, transparent, and with some swelling assumed a spherical or elliptical form, *i. e., utricular germination.* Such a spore, if transferred to a nutrient solution, will germinate and develop a normal thallus; but left in the antiauxic solution, it develops no further than the germ-tube stage.

The complete nutrient solution used contained $C_6H_{12}O_6+NH_4NO_3+MgSO_4+KH_2PO_4+H_2O$. The experiments consisted in determining the maximum concentrations of four salts of copper (the acetate, chloride, nitrate and sulphate) which would allow the utricular germination in the presence of a complete or incomplete nutrient. The results obtained may be briefly summarized as follows:

Neither single mineral salts in solution weaker than the normal, nor organic compounds containing no acid or metal radicals, have any antitoxic value against copper salts for *Penicillium glaucum;* but the salts of K, Mg, NH_4, or organic acids which contain in their structure the groups CH_3, CH_2, or CH singly joined to a functional acid group possess an antitoxic value.

The bases combined with active organic acids determine the relative antitoxic value of the salts of these acids.

The amine group NH_2 destroys the antitoxic value of CH_2. The imide function, OCN, is more or less indifferent. The nitrile group, CN, is distinctly toxic. The organic combinations of C and of N taken singly are therefore inactive.

Carbohydrates, when added to an appropriate mineral salt, exhibit an antitoxic value, which for a constant quantity of appropriate salt vanishes at about the centinormal concentration with aldoses; but goes somewhat higher for ketoses and complex hexoses. The aldehyde and ketone functions play, therefore, a very important function in the antitoxic action of these bodies. The position of the hydroxyl groups in the carbohydrates has very little influence upon the antitoxic value.

The appearance of antitoxic action is dependent upon the simultaneous presence of a combined carbon compound, and of a suitable mineral salt forming an organo-metallic compound, which recalls by its formation and modifications the side-chain of Ehrlich.

The antitoxic value of the carbon group in a mixture varies with the quantity of metal or of mineral salt united to this carbon group.

The dissociation of the mineral salts induces a sudden decrease in their antitoxic value, and the molecules of the useful salts (organic or inorganic combined with carbon compounds) generally appear more active than the ions for the K and Mg salts and also for certain salts of NH_4. The effect of the ions is generally independent of their quantity. Sometimes their effect diminishes proportionally to their quantity, but generally there must be a material diminution in quantity before any effect can be noticed.

Certain salts exhibit specific properties. The antitoxic value of the NO_3 ions becomes zero when the total quantity of NO_3 in solution becomes equal to or less than 0.000352 per cent. SO_4 shows the same phenomenon when the quantity becomes 0.000096 per cent. In the presence of an excess of K, the ions

NO_3 and SO_4 are only active when the former occurs in the ratio of 10:1 of K, and when the latter is present as 200:1 of K. The influence of molecules and ions is zero when phosphates are used.

Magnesium salts possess a greater antitoxic value than the corresponding potassium or ammonium salts. Mixing a small quantity of $(CHOO)_2Mg$ with twice the quantity of CHOOK does not modify the antitoxic value of the former in the presence of copper acetate, but with the other salts of copper its value is increased. The addition of ammonium or potassium salts to a solution of the corresponding magnesium salt decreases but does not increase the antitoxic value of the latter. The mixture of corresponding salts of potassium and ammonium, however, increases slightly their antitoxic value in the presence of some copper salts, but not for others.

A part of the antitoxic activity of mineral salts is due to the acid radicals, the NO_3 radical being the one which is most active. Therefore the inorganic salt possessing the most antitoxic activity is $Mg(NO_3)_2$.

By mixing a small quantity of $(NH_4)_2SO_4$ with twice the amount of CHOOK, the antitoxic value of the former is not modified, except in presence of copper acetate, where the antitoxic value is slightly increased. The K ions appear to decrease the antitoxic value of the $(NH_4)_2SO_4$ molecules. When $(CHOO)_2Mg$ molecules are added to $(NH_4)_2SO_4$ the antitoxic value of the Mg molecules decreases. The mixing of a small quantity of NH_4NO_3 molecules with an equal quantity of CHOOK increases their antitoxic value. The K ions are depressing when they are present in large amounts, but have the same action as CHOOK when they are present in small numbers. When NH_4NO_3 is added to less than half the same amount of $(CHOO)_2Mg$, the first salt exerts a depressing action upon the second.

The addition of a small amount of CHOOK to less than half the same quantity of $Mg(NO_3)_2$ diminishes the antitoxic value of the latter except with the copper acetate, where it is increased. The addition of CHOOK to $S+NH_4+Mg$ or to $P+NH_4+Mg$ raises the antitoxic value of these combinations.

When a small quantity of $MgSO_4$ is added to twice as much NH_4NO_3 the antitoxic value of the mixture is greater than that of the NH_4NO_3 alone, but is greater, equal or less than that of the $MgSO_4$ with different salts of copper. The addition of CHOOK to the mixture is without action upon the antitoxic value, except with $CuCl_2$, where it is lower.

The mixture of a small amount of $NH_4H_2PO_4$ with a smaller amount of $Mg(NO_3)_2$ diminishes considerably the value of the latter. The addition of CHOOK to the two salts raises their antitoxic value.

Mixing a small amount of $Mg(NO_3)_2$ with twice the amount of $NH_4H_2PO_4$ and an equal amount of K_2SO_4 represents a complete mineral nutrient and the maximum of resistance to poison.

The author's conclusions are sustained by a large mass of experimental data which will repay careful reading and constitute an important addition to our knowledge of the relations between poisons and foods.

Howard S. Reed
Department of Agriculture,
Washington, D. C.

Kurzes Lehrbuch der Organischen Chemie. By Dr. W. A. Noyes. Translation into the German by W. Ostwald. Pp. 722. Akademische Verlagsgesellschaft, 1907.

It has seldom happened that an English text in organic chemistry has been translated into the German, inasmuch as organic chemistry is essentially a German science, and practically all of our texts have come from that country. That W. A. Noyes's book has been translated into the German augurs well for organic chemistry in our own country. Especially does this seem true when it is noted that the translator is no other than Walter Ostwald, of Leipzig. The translation is remarkable. The translator has given a faithful representation of the original text, at the same time he has completely eliminated that stiffness so characteristic in translations of this kind.

Geo. B. Frankforter

SCIENTIFIC JOURNALS AND ARTICLES

The American Journal of Science, for August, contains the following articles:

E. T. ALLEN and J. K. CLEMENT: "Rôle of Water in Tremolite and Other Minerals."

G. C. ASHMAN: "Quantitative Determination of the Radium Emanation in the Atmosphere."

R. W. LANGLEY: "Determination of Small Amounts of Barium in Rocks."

W. G. MIXTER: "Heat of Combination of Acidic Oxides with Sodium Oxide and Heat of Oxidation of Chromium."

I. K. PHELPS and L. H. WEED: "Concerning Certain Organic Acids and Acid Anhydrides as Standards in Alkalimetry and Acidimetry."

I. K. PHELPS and L. H. WEED: "Comparison between Succinic Acid, Arsenious Oxide and Silver Chloride as Standards in Iodimetry, Acidimetry and Alkalimetry."

W. E. FORD and E. W. TILLOTSON, JR.: "Orthoclase Twins of Unusual Habit."

J. V. LEWIS: "Palisade Diabase of New Jersey."

F. B. LOOMIS: "New Horse from the Lower Miocene."

THE contents of *The Auk,* for July, are as follows:

E. S. CAMERON: "Observations on the Golden Eagle in Montana."

J. H. RILEY: "Notes on the Broad-winged Hawks of the West Indies, with Description of a New Form."

RICHARD C. HARLOW: "Recent Notes on Birds of Eastern Pennsylvania."

C. J. PENNOCK: "Birds of Delaware—Additional Notes."

J. A. ALLEN: "The Case of *STRIX* vs. *ALUCO.*"

EDWARD J. COURT: "Treganza Blue Heron."

FRANCIS H. ALLEN: "Larus kumlieni and other Northern Gulls in the Neighborhood of Boston."

J. A. ALLEN: "*Columbina* versus *Chæmepelia.*"

JAMES H. FLEMING: "The Destruction of Whistling Swans (*Olor columbianus*) at Niagara Falls."

AUSTIN HOBART CLARK: "The Macaw of Dominica."

TYPES OF AMERICAN GRASSES

UNDER this title, Mr. A. S. Hitchcock has recently published in "Contributions from the U. S. National Herbarium," Vol. 12, Pt. 3, the results of his studies of the types of American grasses described by Linnæus, Gronovius, Sloane, Swartz and Michaux. These studies were made by Mr. Hitchcock in the spring of 1907, at which time he made a detailed examination of American grasses preserved in the larger herbaria of Europe.

The contribution is a noteworthy one and will go far toward fixing names for the American grasses discussed, not alone specifically, but probably in some cases generically as well. The preservation of grass specimens is in most cases satisfactory as they are little subject to insect depredation. In a large majority of instances, Mr. Hitchcock found the type specimen readily and certainly identifiable; in some instances where the author had confused two or more species under one, he was obliged to consider each case upon its merits, and he has presented the evidence on which the type specimen was selected by him. In a few of these cases there is opportunity for difference of opinion, but it seems to the writer that Mr. Hitchcock's decision in such cases should be accepted without further question in all instances in which he has first designated the type.

There are a few species which require transposition of names, as for example, *Cenchrus tribuloides* L., the type of which proves to be the same as *C. macrocephalus* (Doell) Scribn.; the plant which has mostly been known under the name *tribuloides* should bear the name *C. carolinianus* Walter; the study brings out a number of cases in which priority requires the acceptance of earlier published names than those in current use.

It has been perhaps widely assumed that most of the species of the older authors were more comprehensive in including slightly different races than those of recent writers. In some instances this is doubtless true, but in many others the species conception was apparently broad only because the describer had but a single specimen, or at best but few to base an opinion upon. Linnæus proposed some species on specimens which have been regarded by some modern authors as belonging to the same species, the differences being so slight, while on the other hand he some-

times included widely different species in a single one; as a matter of fact, the lines of demarkation between species have usually been matters of opinion and judgment, and we have had and presumably always shall have, authors who will take broad or narrow views. This being the case, the necessity of determining in some way the absolute types of species is becoming more and more apparent, and such a work as the one now reviewed is a valuable contribution to taxonomic literature.

The type specimens of some species could not be found by Mr. Hitchcock, and presumably some of these have been lost; in such instances he has been obliged to base his conclusions upon the original descriptions; three of the species described by Swartz are those apparently preserved without types. If, in such cases we could be sure that the types do not exist, it seems to the writer that it would be advantageous to designate some other specimen as an artificial type, taking all possible care to select such a specimen from the characters assigned in the original description, and from as near the type locality as possible.

A list of new names and those replacing names in current use is appended.

N. L. Britton

DR. JOHN B. TRASK, A PIONEER OF SCIENCE ON THE WEST COAST

Dr. John Boardman Trask, who came to California in 1850, was born in Roxbury, Mass., in 1824. He died in San Francisco, July 3, 1879. His death was a public loss and was so regarded by all who were familiar with his career and varied services to the commonwealth and the community in which he lived.

Following the close of his connection with the United States and Mexican Boundary Survey, he became the first state geologist of California and was one of the illustrious eight who founded the California Academy of Sciences.

Two years and more have passed since the fine building, the home of the academy, the gift of James Lick, was destroyed by fire and earthquake. In considering that memorable event with its various tragic incidents and the loss of the library and collections, there arise from the ruins remembrances of other and earlier days, recollections of that little coterie of eight men who came together on the sixteenth of May, 1853, and organized the first society of natural history west of the Mississippi River—an event in its way equally noteworthy, though lacking the spectacular elements of the April disaster.

Soon after my arrival in California in June, 1858, I became acquainted with most of these pioneers in science, and with some of the earlier recruits who joined the little squad of charter members. Of these latter and their associates[1] it may be said, without injustice to any, that Dr. Trask, by virtue of his genial qualities, untiring energy and all-around ability, was the leader, closely followed by Dr. Albert Kellogg, of precious memory, who in the new environment of his adopted state reveled amid the multifold glories of field and forest and lived, as it were, in a botanical paradise.[2]

That these men and their fellows were regarded in those strenuous hurly-burly days of the "gold fever," as akin to cranks, puttering with their shells, and bugs, and posies, was not an unnatural thought to the average man, hustling for the "almighty dollar" or rather for the "golden nugget." However

[1] Dr. William P. Gibbons, one of the founders, described several species of fishes. Among the very earliest members were Dr. H. H. Behr, entomologist and writer on the Lepidoptera, etc.; Dr. W. O. Ayres, ichthyologist; Hiram G. Bloomer, botanist, and Col. Leander Ransom and Dr. Arthur B. Stout.

[2] Whoever has read Dr. Kellogg's "Forest Trees of California," published in the Second Annual Report of the State Mineralogist of California, 1880–2, will readily admit the propriety of these words. The plants described by him number over 300. A complete list carefully sought from all sources was published by the Academy in 1885 in the form of a Bulletin. Dr. Kellogg died on the 31st of March, 1887, and was buried in Mountain View cemetery near Oakland.

eccentric, time and place considered, they kept "the noiseless tenor of their way," led by the spirit that inspired and possessed them, and builded better than they knew, doubtless, not better than at times they hoped. As Dr. Kellogg was the first resident Californian to describe the botanical forms of the state, so Dr. Trask was the first to describe the recent and fossil shells, as may be seen by reference to the first volume of the *Academy's Proceedings* in 1855–6, which includes the following: *Anodonta Randalli* = *A. angulata* Lea, *Anodonta*[3] *triangularis* = *A. Nuttalliana* Lea, *Anodonta rotundovata* = *A. Wahlametensis* Lea, from the Sacramento River and lagoons, and *Alasmodon Yubaensis* = *Margaritana margaritifera* Linnæus, *var. falcata* Gould, from the Yuba River.

In the same volume certain fossil mollusks are described as follows: *Ammonites Batesii* from Arbuckles Diggings, Shasta County; *Chemnitzia papillosa, Tornatella elliptica, Murex fragilis* and *Fusus Barbarensis,* all from Santa Barbara; *Fusus robustus* and *F. rugosus* from San Pedro, *Ammonites Chicoensis* and *Baculites Chicoensis,* both from Chico Creek, and subsequently the following: *Plagiostoma*[4] *Pedroana, P. annulatus* and *P. truncata* from San Pedro, Calif.

His last paper, "On Nine New Species of Zoophytes from the Bay of San Francisco and adjoining localities," was published in the Academy's Proceedings, March 30, 1857. It described the following: *Sertularia anguina, S. furcata, S. turgida, Plumularia Franciscana, Crisidia gracilis, Crisea occidentalis, Menipea occidentalis, Scrupocellaria Californica,* and *Hippothea amabilis.*

By resolution of the State Senate of California, passed March 26, 1853, Dr. Trask was called upon "for such information as he may possess relative to the Geology[5] of California and productive resources of the state." This report, of which only 2,000 copies were printed, is entitled:

1. "Report of 1853, Geology of the Sierra Nevada or California Range," by John B. Trask, Sacramento, 1853, 31 pp. It contains a sketch of the geology and mineral resources of the eastern valleys of the Sacramento and San Joaquin, and to the coast line within 41st and 42d degrees of north latitude, from personal observations made during the years 1850–52. Reviewed *Mining Mag.,* 1853, vol. 1, pp. 6–23.

2. "Report on the Geology of the Coast Mountains, Embracing their Agricultural Resources and Mineral Productions," also portion of the Middle and Northern Mining Districts, by Dr. John B. Trask, state geologist, Senate Doc. No. 14, Sacramento, 1855, 95 pp. This report contains a description of the physical geography of the Coast Mountains; Geology of the Coast Mountains; Tertiary rocks of the Coast Mountains; Primitive rocks of the Coast Mountains; Volcanic rocks of the Coast Mountains; Geology of the San Bernardino Mountains; Stratified rocks of the San Bernardino chain of Los Angeles; Artesian borings; Soil and productions of Los Angeles; Mineral productions of Los Angeles; Country north of the American River; Mineral district of the Upper Sacramento Valley. Geology of the northern mountains; Local geology of the Northern Coast Mountains; Carboniferous limestone of the eastern part of Shasta County; Trinity County; Structure of the Sacramento Valley; Tertiary rocks and other deposits of the Sierra Nevada; Placer Mining; Quartz veins; Quartz mines, with description of the mines and statistics.

3. "Report on the Geology of the Coast Mountains and Part of the Sierra Nevada,

[3] These and the two following have been regarded for the last twenty-five years by the principal conchologists of the west coast as mutations of *A. Nuttalliana.*

[4] See Dr. W. H. Dall's comments on the Pectens of the West Coast in *Transactions Wagner Free Institute,* Vol. III., Part IV., p. 705, April, 1898, and "The Tertiary and Quaternary Pectens of California," by Dr. Ralph Arnold, U. S. Geological Survey, Professional Paper, No. 47, p. 90, Washington, 1906.

[5] Of the value of Dr. Trask's geological work I am not competent to express an opinion; it should, in common fairness, be judged by the standard of his day, rather than of the present time.

Embracing their Industrial Resources in Agriculture and Mining," by John B. Trask, state geologist, Assembly Doc. No. 9, 1854, 92 pp. Contains a description of the Geology of the Monte Diablo range; Salinas Valley, from Point Pinos to the Nacimiento River; Santa Cruz Mountains; Structure of the valleys of the Sacramento and San Joaquin; Review of the geological changes in the Coast Mountains and Monte Diablo ranges; Classification of the rocks of the Coast Mountains and Monte Diablo ranges; Position and relation of the volcanic rocks of the Tertiaries; Volcanic rocks preceding the Tertiary era; Most recent volcanic rocks of the Coast Mountains; Changes of level and river terraces; Soils of the Santa Clara valley and shores of the Bay of San Francisco; Valley of the Salinas; Soils of the Salinas, Pajaro Valley, Livermore Valley; Mineral resources of the Coast Mountains; Mineral districts, embracing parts of the counties of Nevada, Placer, El Dorado and Calaveras; Quartz veins and their relative age in California; Character and position of the older veins below the surface; Present government of metallic veins: Description of the mines, with a list of gold mines.

4. "Report on the Geology of Northern and Southern California, Embracing the Mineral and Agricultural Resources of those Sections, with Statistics of the Northern, Southern and Middle Mines," by Dr. John B. Trask, Assembly Doc. No. 14, Session of 1856, 66 pp. Contains a description of the physical geography of the Coast Mountains, lying north of the Bay of San Francisco; Geological structure of the Coast Mountains; Mineral character of the primitive rocks of the Coast Mountains; Soils of Petaluma County; Plains west of the Sacramento River; San Bernardino; Geology of Table Mountain, Tuolumne County; Carboniferous rocks of the northern district; Salines of the Upper Sacramento Valley; Description of mines, etc.; Analyses of saline waters from Lick Springs, Shasta County; Gold mines in operation in 1855; Table of altitudes.

5. "Report on the Geology of the Sierra or California Ranges," by John B. Trask; *Pharmaceutical Journal,* vol. 14, 1855, pp. 20–24.

His numerous papers on earthquakes in California from 1812 to 1865 need only to be mentioned here.[6] These have been listed by General Vogdes[7] as well as Dr. Trask's other papers. This list of titles I have quoted *in extenso* from the General's paper.

Dr. Trask's medical education, we learn from Dr. Kellogg, was broadly thorough. He successfully passed examinations in geology, mineralogy, technical and applied chemistry, proximate and ultimate analysis, microscopy, medical botany, surgery, theory and practise of medicine, and cognate sciences, completing the course of lectures required for the certificate of the Yale faculty, according to the laws of Connecticut. That he profited by and made good use of these studies is evident from his performance and the honorable recognition he received from various European and American learned bodies and honorary degrees from abroad for his researches in organic chemistry, mineralogy, microscopy and medical botany.

The following species of Californian mollusks, recent and fossil, have been named in his honor: (1) *Limnæa Traskii* Tryon; (2) *Helix* (*Epiphragmophora*) *Traskii* Newcomb; (3) *Actæon Traskii* Stearns; (4) *Meretrix Traskii* Conrad; (5) *Ammonites Traski* Gabb; (6) *Carbula Traski* Gabb; (7) *Nucula Traskana* Meek; (8) *Patella Traski* Gabb; (9) *Pecten Traski* Gabb.

[6] Dr. Trask's data are practically embodied in Dr. E. S. Holden's "Catalogue of Earthquakes on the Pacific Coast, 1769 to 1897," *Smithsonian Miss. Coll.*, 1087, Washington, D. C., 1898.

[7] "A Bibliographical Sketch of Doctor John B. Trask," etc., by Anthony W. Vodges, with portrait, pp. 27–30, *Trans. San Diego Society of Natural History,* Vol. I., No. 2, 1907. See, also, *Proc. Calif. Acad. Sciences,* Vols. I., II., III., and "Catalogue California Fossils," compiled by J. G. Cooper, M.D., in Seventh Annual Report of State Mineralogist, Sacramento, State Printing Office, 1888. "Remarks of Dr. A. Kellogg on the late Dr. John B. Trask before the California Academy of Sciences, July 21, 1879."

Numbers 2 and 3 are living and Quaternary, and 5–9, inclusive, are Cretaceous (and Eocene) of Cooper's Catalogue.

Through him the medical profession of the west coast was first made acquainted with the mode of preparation and therapeutic effects of Mentel's aluminated solution, Pravoy's solution of perchloride of iron, Monrel's salt and the syrup of superphosphate of iron and its combinations; liquid propylamin, an antidote for rheumatism of the acute type, liquid rennet or pepsin wine for gastralgia, etc., and other valuable medicaments.

Among the plants, the virtues of which he either discovered or made known to the profession were yerba santa (*Eriodictyon*), for rheumatism, gout, etc.; *Damiana,* a nerve tonic and aphrodisiac; *Grindelia robusta* for oak or rhus poisoning and asthma, in certain cases; yarrow (*Achillea millifolium*), which he proved to be an efficient emmenagogue; canchelagua (*Erythræa,* of the West Coast), a bitter tonic and antifebrile; *Aspidium argutum* root (kidney fern), as an antidote for the tapeworm; manzanita leaves (*Arctostaphylos*) as an antilithic kidney and bladder tonic; and tincture of *Kalmia latifolia* as an extraordinary sedative, etc.

In 1858, when I made his acquaintance, he commenced the publication, in conjunction with Dr. David Wooster, of the *Pacific Medical and Surgical Journal,* which, after many years of conscientious and laborious editorial work, passed out of his hands into the charge of other members of the profession.

In the great struggle of the civil war for the preservation of the union, he followed the flag as assistant surgeon of volunteers. As a physician he was skillful, quick and accurate in diagnosis, prompt and resourceful in practise, quite free from the acquisitive instinct, and like his Oakland friend, Dr. Newcomb,[8] and his old-time friend and collaborator in the academy, Dr. Kellogg, from whom I have largely quoted, "earnest and generous hearted, ever ready to serve those who needed his services without money and without price, and ever ready to lend a helping hand or do a kindly deed."

I knew them well and I could relate many incidents of my own knowledge, illustrative of their goodness and benevolence. In the twilight of old age, looking back to those days of frequent and sympathetic contact, brought together as we were by similarity of tastes and habits of thought, memory recalls their generous natures and sterling qualities, and inspires the hope that these men may not be altogether forgotten.

ROBERT E. C. STEARNS
LOS ANGELES, CAL.

[8] Dr. Wesley Newcomb, born in the state of New York in 1808. He made Oakland his home in 1858, where he resided for about ten years. He is well known by his conchological writings, especially on the land shells (Achatinellidæ) of the Hawaiian Islands, where he practised medicine for five years. He died in Ithaca, N. Y., on January 26, 1892. See *The Nautilus,* Philadelphia, March, 1902.

SPECIAL ARTICLES

THE GRADING OF STUDENTS

THE problem of how students should be graded in order to make the results of grading equitable is of interest to the psychologist both as a theoretical and as a practical problem. Its practical aspect must be of the greatest importance to any teacher in any subject, in school or college. Professor W. S. Hall[1] published a paper on this subject a few years ago, the conclusion of which is that average classes of students, doing honest work and marked equitably, will yield results which when tabulated should conform to the binomial curve, *i. e.,* the number receiving medium marks should far exceed the number receiving high or low marks. The solution of the problem, then, consists merely in the fulfilment of two conditions, honesty on the part of the student and equity on the part of the instructor when applying the marks agreed upon by the faculty. Actually, however, the problem is still far from its solution.

[1] "A Guide to the Equitable Grading of Students," *School Science and Mathematics,* Smith & Turton, Chicago.

Professor Hall uses the marks AAA, AA, A, BB, B, CC, C, D, and E; nine marks in all. He does not tell us, however, how these marks are to be defined. The mere reference to a particular curve of distribution does not define the marks unless the difference of ability represented by each two adjoining marks is identical. But Professor Hall tells us that he does not regard them as identical. AAA he regards as equivalent to 99 to 100 per cent. Per cent. of what? He does not tell us. Of questions permitting only an affirmative or a negative answer and answered correctly in oral or written examinations? I am not sure that he means this exactly and exclusively, since he speaks also of the grading of laboratory note books. But I shall assume that he means the percentage of correctly answered questions. AA is regarded as standing for 95 to 99 per cent. The distance between the centers of the abilities AAA and AA is, therefore, 2.5. If we examine the other distances in the same manner we find them to be 4.5, 5, 5, 5, 5, 7.5 and 10. If the horizontal coordinate is divided by a scale of such unsymmetrical units, reference to a symmetrical curve has little meaning. It seems to me that the chief fact brought out in Professor Hall's paper is this: If a teacher, in grading his students, proceeds on the principle that the number receiving medium marks should far exceed the number receiving high or low marks, the accumulated results of his grading are likely to agree with his principle. But who would expect this to be otherwise? No one, however, will expect uniformity of grading in a whole institution to result from the fact that each teacher is guided by that principle, unless the various marks are defined. Is it possible to define the marks used, as standing for definite percentages of right answers? I do not believe, judging from my own experience in teaching, that students can be ranked by such a mechanical method. And if a teacher insisted on ranking them by such a method, he would often find that the result does not agree with Professor Hall's binomial curve. I tested the native musical ability of seventy-one students. The nature of the test

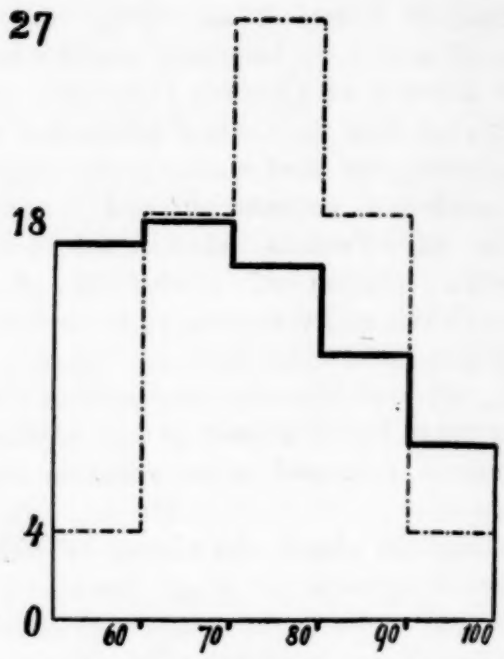

FIG. 1.

will be described elsewhere and its appropriateness demonstrated. The accompanying curve (Fig. 1) shows how the ability in question was *found* to be distributed (continuous line) and how it *should* be distributed according to Professor Hall (dotted line). There was in this case no distortion of the curve by either dishonesty of the students or any "personal equation" of the teacher. The grading consisted in the mechanical process of counting the right answers. Nothing is easier, of course, than to distribute the students in accordance with Professor Hall's curve, if we do what he has done and apply to the horizontal coordinate a scale of unequal units. But what is the use of it? Thus far I can not see any.

Five years ago the faculty of the University of Missouri voted that the grades of the institution should be A, B, C, D and E. What those grades should mean was left undefined, except that D and E were both called failures, with the distinction that D students were permitted to prepare privately for a second examination, and E students were not. It is highly interesting to see how the assumption that every teacher would know what the different grades stood for, has worked out in practise. I have collected the reports of forty teachers of the university during the last five years, all with two exceptions professors or

assistant professors, and most of them connected with the College of Arts and Science. The result of this investigation is that the experiment started by the faculty five years ago must be pronounced a complete failure. And both students and faculty have before now felt it to be a failure. There is no uniformity of grading, but the greatest divergence. It has come to be admitted openly that a student who is anxious to win honors must be careful to elect his work under certain teachers and avoid others as much as possible.

In order to compare the grading of the different teachers, I have divided the total number of the students of each teacher during the last five years into three groups, one representing the 50 per cent. medium students, one the 25 per cent. superior students and one the 25 per cent. inferior students. Classes of less than four students were not taken into account at all, because they would have unduly increased the coefficient of variability without signifying anything corresponding thereto. The percentages of grading, on the other hand, are not perceptibly changed by this omission. A few of the forty teachers are no longer connected with the university. The two classes of failures have been combined into one, marked F, because a number of the teachers do not make any use of the grade D, not wishing to express the privilege of reexamination in the grade, since the student's rank is

Teachers	25 Per Cent. Superior Students			50 Per Cent. Medium Students				25 Per Cent. Inferior Students			Total Number of Students	Number of Classes	Coefficients of Variability			
	A	*B*	*C*	*A*	*B*	*C*	*F*	*B*	*C*	*F*			*A*	*B*	*C*	*F*
Philosophy	25	—	—	30	20	—	—	13	10	2	623	29	.2	.3	.8	1.2
Latin I	25	—	—	27	23	—	—	19	6	—	130	9	.3	.3	1.2	—
Sociology	25	—	—	27	23	—	—	7	13	5	958	47	.3	.5	.9	.9
Mathematics I	25	—	—	15	31	4	—	—	12	13	208	19	.6	.6	.8	.9
Economics	25	—	—	14	36	—	—	1	19	5	461	28	.4	.4	.7	.9
Greek	25	—	—	14	26	10	—	—	14	11	287	30	.4	.4	.5	.9
Latin II	25	—	—	11	39	—	—	1	19	5	577	32	.6	.4	.6	1.0
French	25	—	—	11	29	10	—	—	15	10	295	16	.3	.4	.4	.9
Political Science	25	—	—	9	30	11	—	—	16	9	592	?	.3	.3	.3	.4
Mathematics II	25	—	—	7	29	14	—	—	9	15	145	10	.6	.4	.4	.9
German I	25	—	—	5	39	6	—	—	14	11	586	28	.6	.4	.6	.8
Psychology I	25	—	—	5	36	9	—	—	15	10	907	37	.5	.4	.5	.7
German II	25	—	—	1	38	11	—	—	14	11	941	35	.3	.2	.4	.4
Elocution	20	5	—	—	50	—	—	6	19	—	917	12	.5	.1	.5	—
Geology	22	3	—	—	45	5	—	—	17	8	293	?	.2	.2	.3	.2
History I	14	11	—	—	42	8	—	—	19	6	779	21	1.0	.2	.5	.8
Zoology I	21	4	—	—	41	9	—	—	19	6	479	19	.6	.3	.5	1.1
Psychology II	19	6	—	—	41	9	—	—	20	5	238	9	.4	.2	.3	1.1
History of Art	25	—	—	—	40	10	—	—	20	5	685	55	.5	.3	.3	1.1
Bacteriology	20	5	—	—	40	10	—	—	21	4	263	20	.5	.4	.6	1.2
Freehand Drawing	18	7	—	—	40	10	—	—	15	10	506	32	.8	.3	.4	.9
Chemistry I	23	2	—	—	38	12	—	—	19	6	205	16	.4	.3	.4	.7
English I	21	4	—	—	37	13	—	—	17	8	964	33	.7	.3	.4	.8
Astronomy	13	12	—	—	37	13	—	—	20	5	225	17	.5	.3	.4	1.4
History II	11	14	—	—	37	13	—	—	20	5	806	35	.7	.2	.3	1.0
Zoology II	24	1	—	—	36	14	—	—	17	8	250	?	.6	.3	.4	1.0
German III	22	3	—	—	34	16	—	—	12	13	441	26	.6	.6	.4	.8
Chemistry II	9	16	—	—	32	18	—	—	25	—	21	4	1.4	.6	.5	—
Education	18	7	—	—	31	19	—	—	16	9	266	12	.5	.3	.2	.7
Mathematics III	19	6	—	—	30	20	—	—	6	19	182	10	.4	.3	.3	.4
Mathematics IV	25	—	—	—	29	21	—	—	15	10	380	24	.4	.3	.3	.7
Physiology	20	5	—	—	28	22	—	—	18	7	426	30	.9	.3	.3	1.1
Anatomy	19	6	—	—	28	22	—	—	14	11	544	25	.6	.3	.3	.8
Mathematics V	16	9	—	—	25	25	—	—	10	15	209	10	.4	.3	.2	.4
Engineering I	13	12	—	—	24	26	—	—	16	9	813	39	.6	.3	.2	1.0
Mechanical Drawing	18	7	—	—	22	28	—	—	13	12	558	28	.4	.4	.3	.9
Mechanics	18	7	—	—	19	31	—	—	11	14	495	12	1.1	.3	.3	.4
Engineering II	16	9	—	—	17	33	—	—	13	12	826	?	.3	.3	.3	.9
English II	9	16	—	—	12	35	3	—	—	25	1098	44	.8	.3	.3	.4
Chemistry III	1	11	13	—	—	47	3	—	—	25	1903	12	1.0	.6	.1	.3

not the exclusive condition on which the possibility of reexamination depends.

To eliminate as much as possible the personal element from the publication of the results of this investigation, I have not given the names of the teachers, but only the subjects taught, and in the case of several teachers of the same subject I have added Roman numerals for distinction. For the student of similar phenomena I have added the total number of records of each teacher, the number of classes, in order to indicate the average size of the classes, and the coefficients of variability. In the first case of the table the average total per cent. of A's is given as 55 and the coefficient as .2. This means that in a class of 100 students of this teacher it is just as probable that the number of A's will be between 44 and 66 as it is that the number of A's will be outside of these limits; and that it is three times as probable that the number of A's will be less than 66 per cent. as it is that it will be more. In the last case of the table the total percentage of A's is 1 and the coefficient 1. This means that it is three times as probable that in a class of one hundred there will be one or two A's as it is that there will be none.

Let any one look over the four columns of the 50 per cent. medium students and ask himself if he can see uniformity of grading. Above we see that none of the students of medium ability receive the grades of C or F, but all receive either A or B. Below we see that none of the students of medium ability receive the grades of A or B, but all receive either C or F. And yet, on the basis of these grades the faculty gives "honors," returns to their parents students who have "accumulated failures," compels students to take twice the same work if this happens to be required for graduation, and prevents students from taking up work in departments to which they are drawn by their natural inclinations and from which they might derive the greatest benefit for their later life. But let no one think that this proves that the University of Missouri is in a pretty bad shape. It is not likely that other institutions are better off. Only, no one has investigated the matter. Education is just beginning to realize that it is not merely an art, but an applied science.

Can anything be done to make such inequalities of grading impossible? There is no reason why one should believe that this could not be accomplished. I shall outline a method by which one might proceed.

It seems plausible to start from the assumption that the combined mental and moral ability which we want to measure is distributed among different people in accordance with the probability curve which describes, *e. g.*, the distribution of accidental errors in scientific observation. Fig. 2 shows such a curve. The

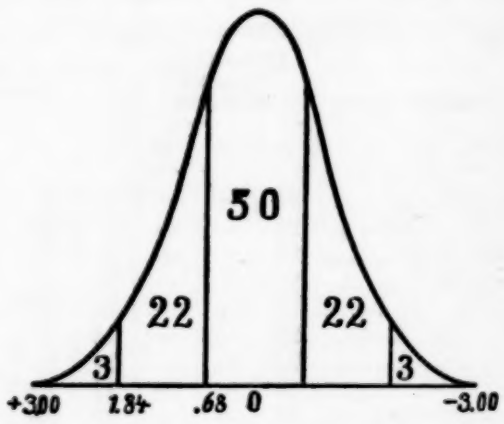

Fig. 2.

total area enclosed represents one hundred students making up the membership of a particular class. The first problem which confronts us is the division of this area. It seems best not to proceed entirely arbitrarily in this division, but to follow the custom already established. Whenever this curve is used for scientific purposes, its area is divided by verticals in such a manner that a middle area is cut out which is equal to the sum of the two areas left at the sides. The significance of this division is this: If we pick out a student at random from a crowd of one hundred, the chances are the same that we shall have a student of medium ability as that we shall have one who is not of medium ability. If the latter happens to be the case, he may be either a superior or an inferior student. Before we discuss the problem of further division, let us give an answer to the

question to which of these groups of students the methods of teaching and of maintaining discipline should be adapted. Plainly to the 50 per cent. of medium students. If these are taught in such a way that they are able to grasp what is presented, the superior ones will take care of themselves, and a large percentage of the 25 inferior ones will derive considerable benefit from the instruction. The same holds true for the method of maintaining discipline, of insuring the necessary regularity and intensity of intellectual work in class and at home.

If these assumptions are made, it follows that in no case should the *highest* grade established in any institution be given to more than 25 per cent. of the students of a class on the average of a number of years. The *highest* grade, if there is any difference of grades at all, must mean distinction. But it ceases to have this meaning if it can be obtained by a student of medium ability. We have seen above that a large percentage of the medium students have been able to obtain the grade of distinction. This fact may be explained by the teachers who are responsible for it in two ways.

1. A teacher may be guided by the conviction that the very fact of a student electing his work under his instruction proves that he is a superior student and that he ought to obtain a grade higher than the average grade. The absurdity of this assumption can easily be shown. In order to show this it is by no means necessary to put all studies on the same level, in our opinion. Some may be more valuable, some may be more difficult, than others. But to decide this is not the teacher's task when he grades his students. If a student excels, this means, of course, that he excels among the students who are taking the same instruction which he is taking. An analogous case in the broader life of a nation will make this still more clear. If we say that a certain physicist is a distinguished scientist of the country to which he belongs, we do not mean that he ranks high among botanists, physiologists and geologists, but that he ranks high among the physicists. Important suggestions towards the solution of problems of this kind may be found in Professor Cattell's paper on "American Men of Science." In the same way, when a student is ranked as a superior student by his Latin teacher, this can mean only that he does better work than 75 per cent. of the students in Latin. Whether he is more intelligent than 75 per cent. of all the students in the institution is a question which his Latin teacher is not called upon to answer, and which not even the scientist to whose domain this question belongs, the psychologist, is able to answer at present, and, possibly, will never be able to answer. It can not even be said, in justification of giving the highest grade to students of the middle 50 per cent. group, that most of the students taking work under this special teacher are doing advanced work, and that this fact proves that they are superior students. If this argument were admissible higher grades would have to be used in college than in the high school, and here again higher grades than in the elementary school. If a student is said by his teacher of comparative philology to have distinguished himself, this can mean only that he has distinguished himself among the students who are taking work in comparative philology, and not that he ranks high among students taking first-year Latin.

2. A teacher may say that by accident he happened to have unusually good students. This is a sufficient explanation for giving students of a rather small class in a special year unusually high grades. But it is the very nature of an accident that it occurs but rarely. If a teacher feels that he should give six of ten students the highest grade, he should first ask himself if these students are so extraordinary that not in ten or twenty years is such a good class likely to be found again. If he does not feel that this is probable, he can not justify giving a majority of the class the highest grade. They ought to receive the second grade, however satisfactory their work may have been. They have no claim on the grade of distinction. Under no circumstances, therefore, can a teacher justify his grading if it is found that of the total

number of students having taken work under him during a number of years, some of the 50 per cent. medium students have received the highest grade.

Let us now consider the 25 per cent. inferior students. If most or all of these students fail under a particular teacher, there may be but little objection. But if we find, as we actually do, that even some of the medium students fail, we have the right to conclude that the educational principles of the teacher are unsound. Either his methods of teaching and of maintaining discipline are defective, are not adapted to the medium group of students, or his conception of what a student ought to accomplish is altogether one-sided. If a student of chemistry wants to pursue advanced courses in chemistry, it may be necessary that he have a better knowledge of elementary chemistry than the seventy-fifth in a series of a hundred can obtain. This is a matter to be decided between the teacher of chemistry and the student. But it is not a sufficient reason for regarding the student's work as a failure. He may have acquired a sufficient knowledge of chemistry to take up, say, elementary work in botany. It is the teacher of botany who should decide *how much* knowledge of chemistry his student ought to possess. But if the teacher of chemistry grades the work of a student of the medium group as a failure and compels the student to take the work over, he does injustice not only to the student, but also to the teacher of botany, he encroaches upon ground where not he, but his colleague of another department, has jurisdiction. It is no more justifiable to grade 25 per cent. or more of the students as failures than to give 25 per cent. or more the highest grade. Still another argument might be offered by a teacher who grades students of the group of the medium 50 per cent. as failures, in justification of his habits. The teacher of English, for example, may say that students are so poorly prepared in English that more than 25 per cent. ought to fail, ought to be made to take the course a second time. But the teacher, in grading thus, usurps a right which legitimately is not his. If the students are not sufficiently prepared in some lines, he ought to persuade those who are responsible for the entrance requirements that these requirements must be changed, must be raised in some respects. But if the students are once admitted to college, the teacher of a particular subject has to accept them and adjust his methods of instruction and grading to the medium group. He has no right to establish arbitrary standards for the classes which he teaches himself.

We have divided all students taking a particular kind of work into three groups, medium students, inferior students and superior students. Should we subdivide these groups?

Little can be said in favor of subdividing the medium group. That this group is the largest, is, in itself, no reason for subdividing it. A strong argument against subdivision is the fact that this would bring about unjust grading of a large number of students. The curve is highest for medium ability. If we divide the area by a vertical line, we must have a large number of students on one side differing by an almost infinitesimal amount of ability from a large number on the other side. If the teacher, nevertheless, has to give them different grades, the probability is that a considerable number will receive grades either too high or too low. This probability of injustice must be avoided as much as possible. It can be largely avoided if we make subdivisions only where the curve is comparatively low; and it is best, therefore, to give all the students within the central area of 50 per cent. the same grade. This conclusion differs slightly from that of Professor Cattell in his discussion of the same problem.[1] He places only 40 per cent. in the central group. His reason is that otherwise it would not be possible to have each grade represent the same *range* of different abilities and, at the same time, to comply for the sake of conservatism with the custom of having as many as 10 per cent. students receiving the highest grade. Now, as the table shows, this custom does not exist in the University of Missouri, where cus-

[1] "Examinations, Grades and Credits," *Popular Science Monthly*, February, 1905.

tomarily about 25 per cent. receive the highest grade. And to comply with *this* custom would mean more conservatism than one can be expected to possess. On the other hand, equal range of abilities for all grades is impossible, since the probability curve extends infinitely in both directions of the central point, so that the range of the lowest and of the highest grade must always—theoretically at least—be infinite. It further seems to me of more importance that the distances between the *average abilities* of the groups (represented by the position of the geometrical center of the group) be approximately the same than that the ranges be the same. I shall make use of this principle later on. Taking all these conditions into account, I am inclined to prefer 50 per cent. for the central group.

More advisable than a division of the medium group of students seems a subdivision in the group of superior students. To belong to the group of the 25 per cent. best is not a great distinction. It would be well, therefore, to separate from the group those who possess unusual ability. The manner of subdividing the group is a matter of convenience. We may proceed in the following way. In the probability curve (Fig. 2) the point of extreme ability, where the height of the curve is practically zero, is chosen as 3. The point of the vertical line which separates the superior from the medium students is then .68, as can be read off from any table containing the values of the probability integral. It suggests itself to divide the ability-difference between this point and the extreme point, 3, into two equal parts. The result of this division is the point 1.84. To the left of this point are then found 3 per cent. of all the students, as can again be read off from any table of the probability integral. We have thus divided the group into two parts in such a way that the best possible student is as much better than the best student of the second class, as this one is better than the best of the medium class. Let us, then, call the 3 per cent. just separated by the name of "excellent" and retain the name of "superior" for the 22 per cent. following.

In the same manner we may subdivide the group of inferior students, calling the 3 per cent. worst "failures" and retaining the name of "inferior" for the other 22 per cent.

I expect to meet with opposition when I restrict failures to such a small percentage. But I believe that 3 per cent. is a sufficient number in order to weed out those who have succeeded in entering college, but are entirely unable to do the work which they have chosen. I can not regard it as just to grade the other 22 per cent. as failures. But I do not mean by this that they ought to be permitted to take advanced work in the same line of study or to enter courses of other departments for which this particular study is required, or that they should receive credit for the whole number of hours. The teacher who gives these advanced courses and the teacher who gives the course of the other department must have the power to admit or to exclude these 22 per cent. students as he deems best. And the faculty should decide what fraction of the regular number of hours of credit they should receive. Similarly, the faculty should, as Professor Cattell has proposed, give more than the usual number of hours of credit to those students who have excelled the medium 50 per cent. To make all this possible the teacher must place each student in the group to which he belongs according to his rank. But those whose rank puts them in the fourth group should not be called failures in every possible sense, should not be regarded as having accomplished nothing. If a teacher instructs his class in such a manner that according to his own judgment 25 per cent. of them accomplish nothing, then the conclusion is justifiable that the teacher as a teacher has not accomplished anything, either.

The University of Missouri, as mentioned above, has two grades, D and E, both of which mean failure, but with this difference, that students who may be permitted to make up their deficiency by private work are graded D, whereas those who can receive subsequent credit for the course only by taking it over in class are graded E. To the present writer

it remains incomprehensible why this decision of the method of making up a deficiency, which can be made only by the individual teacher in the individual case, should determine a difference of grade. The grade to be recorded on the books of the institution should signify the student's rank and nothing else.

We now have before us this entirely practical question: If an institution adopts a system of grading like the one proposed, in which 3 per cent. are called excellent, 22 per cent. superior, 50 per cent. medium, 22 per cent. inferior and 3 per cent. failure, how can the individual teacher, who is perhaps in charge of a class of only five or eight students, comply with the system? There is only one answer to this question: He must work out his method of grading for himself on the basis of his individual experience with the students. But he should be given one kind of aid by the institution which he serves. The institution should publish annually a statistical table showing how each teacher has graded all his students the last year and the last five years, so that each teacher can inform himself easily as to whether he has graded his students in accordance with the system adopted by the institution or has unconsciously applied an arbitrary standard of his own and thus introduced confusion into the system. There can be little doubt that this would soon result in a great uniformity of grading, and inequalities of the size described would be impossible, to the satisfaction of both faculty and students.

One problem is still left. How should the ability of the five groups of students be represented in order to compute the claims of various students for honors which are to be given to those having the highest rank of a whole student body. The University of Missouri prescribes for this purpose that the first grade be represented by 95, the second by 85, the third by 75 and the fourth by 65. These values are so arbitrarily chosen that any one can see that no scientific influence has been effective grading on the probability curve, as we have tried to do, we are able to give a reasonable answer to the present question. In Fig. 2 the ability of the average medium student is found at the point where the abscissa is 0. The ability of the average superior student is found near $+1$, that of the inferior student near -1. The ability of the average excellent student is found near $+2$, that of the average failure student near -2. All these differences of ability are represented by steps which are about equal. To avoid negative values, it would, therefore, be the simplest method to represent the different grades agreed on by the numerical values 5, 4, 3, 2 and 1, and to multiply these values by the number of hours of work for which each grade has been received. The students whose totals are highest—making allowance for the probable error, which is about .04, if the total number of grades recorded during the college course is about 40—have then the best claims for the honor as far as scholarship is concerned.

Max Meyer

University of Missouri

A NEW COLOR VARIETY OF THE GUINEA-PIG[1]

Experimental studies made in recent years show that color inheritance in mammals is a matter of considerable complexity, but not beyond the possibility of analysis. The more carefully the matter is studied, the clearer does the fact become that color inheritance, in all its phases, conforms with Mendel's law of heredity. The seemingly complicated results are due to multiplicity of factors concerned in the production of those results. If we confine our attention to one factor at a time, we find that its behavior is strictly and simply Mendelian. Each factor is either present or absent and in general the presence of a factor is dominant over its absence. It is only when two or more independent factors are simultaneously concerned that complications arise. Thus two simple factors acting simultaneously may produce a result different from that of either factor by itself.

In the issues of Science for January 25, 1907, and for August 30, 1907, I have advocated the view (first advanced concerning mice

[1] Published by permission of the Carnegie Institution of Washington.

by Bateson[2]) that in the pigmentation of guinea-pigs, three different kinds of pigment are produced, viz., black, brown and yellow. In wild guinea-pigs (Cavidæ) these pigments are so placed on the individual hair as to give it a banded appearance, and the banding is inherited as a factor independent of the colors present. In tame guinea-pigs this pattern factor may be wanting, together with one or more of the fundamental color factors, and this loss of color factors gives rise to a long series of color variations. But any mating which will bring together in one individual all of the four color factors will result in a return (reversion) to the coat condition of the wild Cavidæ.

In the issue of SCIENCE for August 30, 1907, I showed that, if the hypothesis of an independent color pattern (barring of the hair) is correct, it should be possible to produce a color variety of guinea-pig at that time unknown, one similar to the cinnamon-agouti variety of mice. In confirmation of the hypothesis, I may now say that this variety has recently been produced, and in the following way: Agouti-colored individuals were crossed with chocolates. The young were all agouti-colored. But when mated with each other these agouti young produced offspring of four sorts, agouti, black, cinnamon-agouti and chocolate. The cinnamon agoutis are a sharply defined and unmistakable new variety, differing from the wild (agouti) type in the total absence of black pigment from the eye, the skin of the extremities, and from the hair. The black young obtained from this cross, in generation F_2, were an unpredicted result which serves further to confirm the hypothesis of independent factors.

Let us now apply the hypothesis to the facts observed. The original agouti parents by hypothesis carry the four factors: (1) black, (2) brown and (3) yellow pigments, and (4) the barring pattern (agouti), and have completely the wild type of pigmentation. The chocolates, however, have hair entirely devoid of black pigment and unbarred. They lack, therefore, the factors black and agouti (barring).

In crosses of chocolate with agouti individuals, agoutis only are obtained, as already stated, the presence of the factors black and agouti dominating their absence. Using symbols, *B* for black, *Br* for brown, *Y* for yellow and *A* for agouti, the parental contributions in this cross are: by the agouti parent, *B Br Y A;* by the chocolate parent, *Br Y*. The young, therefore, are heterozygotes of the formula, *B Br Y A · Br Y*. Such individuals should, in accordance with Mendelian principles, produce ripe germ cells of four sorts: viz., (1) *B Br Y A*, (2) *B Br Y*, (3) *Br Y A* and (4) *Br Y*. These four sorts should, on the theory of probabilities, be equally numerous Each sort, if united with a germ cell having the same constitution as itself, should produce a different color variety, these four varieties being, respectively, (1) agouti, (2) black, (3) cinnamon-agouti and (4) chocolate.

The result should be visibly the same if a gamete united with one of another sort containing fewer factors than itself, but none of them different from its own factors. Thus the first sort of gamete should produce an agouti individual if united to either of the other three sorts. Allowing for such unions in their chance frequencies, we should expect the second generation offspring to consist of four visibly different sorts of individuals, on the average, in the following proportions; agouti, 9; black, 3; cinnamon-agouti, 3; chocolate, 1. Up to the present time there have been obtained, of agouti, 8; black, 4; cinnamon-agouti, 2; chocolate, 2. This is a perfectly normal Mendelian result, both qualitative and quantitative, and confirms in the most complete manner the hypothesis of an independent pattern factor. For, can a more severe test of the hypothesis be conceived than that by its application one should produce a wholly unknown variety?

A moment's consideration of this case shows what a really great advance in the theory and practise of breeding has been obtained through the discovery of Mendel's law. What a puzzle this case would have presented to the biologist ten years ago! Agouti crossed with chocolate

[2] *Proc. Zool. Soc. Lond.*, 1903.

gives in the second filial generation (not in the first) four varieties, viz., agouti, chocolate, black and cinnamon. We could only have shaken our heads and looked wise (or skeptical).

Then we had no explanation to offer for such occurrences other than the "instability of color characters under domestication," the "effects of inbreeding," "maternal impressions." Serious consideration would have been given to the proximity of cages containing both black and cinnamon-agouti mice.

Now we have a simple, rational explanation, which any one can put to the test. We are able to predict the production of new varieties, and to produce them.

We must not, of course, in our exuberance, conclude that the powers of the hybridizer know no limits. The result under consideration consists, after all, only in the making of new combinations of unit characters, but it is much to know that these units exist and that all conceivable combinations of them are ordinarily capable of production. This valuable knowledge we owe to the discoverer and to the rediscoverers of Mendel's law.

W. E. Castle

Zoological Laboratory,
Harvard University,
July 15, 1908

THE ORIGIN OF VARIETIES IN DOMESTICATED SPECIES

The great diversity of varietal forms, or races, amongst domesticated animals and plants, as compared with the corresponding wild species has always been a subject of remark, and it has generally been assumed that domestication, involving as it does radical changes in environment, induces variation. The considerations mentioned below indicate that we may have given too much prominence to the effect of domestication in inducing variation. It will be seen that, at least in many cases, domestication merely gives opportunity for the segregation and development of variations which may have existed practically unnoticed in the wild species.

The writer has previously shown that the poll character in cattle is a dominant Mendelian character, the dominance being somewhat variable, but the heterozygotes always being distinguishable from the extracted recessives. Let us suppose that a number of polled and horned cattle be allowed to interbreed freely. Let the number of the original polled cattle be a, and the horned cattle i, both types being equally divided between the sexes. The total number of cattle is $a+i$. The chance that in any mating the male shall be polled is $a/a+i$, the chance that it is horned is $i/a+i$. The chance that the female is of a particular type is the same. The following table (table I.) shows the probability of each of the various types of matings, and the corresponding probability of progeny of each type. Since the denominators of all the probability fractions in this table are the same, and since we are concerned only with the ratios between the types, only the numerators of the fractions are used.

TABLE I.

Ratios of Types of Progeny descended from polled (a) and horned (i) cattle, under conditions of random mating. (A = polled character, a its absence.)

Generation F_0.

Type numbers	I	II	III
Type formulæ	AA	Aa	aa
Ratios of types	a	—	i

Generation F_1.

Matings M.	Matings F.	Probability of mating	Probability of progeny of each type		
I×	I	$a\times a$	a^2		
I×	III	$a\times i$		ai	
III×	I	$i\times a$		ai	
III×	III	$i\times i$			i^2
			a^2	$2ai$	i^2

Generation F_2.

I×	I	$a^2\times a^2$	a^4		
I×	II	$a^2\times 2ai$	a^3i	a^3i	
I×	III	$a^2\times i^2$		a^2i^2	
II×	I	$2ai\times a^2$	a^3i	a^3i	
II×	II	$2ai\times 2ai$	a^2i^2	$2a^2i^2$	a^2i^2
II×	III	$2ai\times i^2$		$a\,i^3$	$a\,i^3$
III×	I	$i^2\times a^2$		a^2i^2	
III×	II	$i^2\times 2ai$		$a\,i^3$	$a\,i^3$
III×	III	$i^2\times i^2$			i^4
			$a^2(a+i)^2$	$2ai(a+i)^2$	$i^2(a+i)^2$
		or	a^2	$2a\,i$	i^2

From which it is seen that after generation F_1 there is no tendency for the ratios of the three possible types to change, any such change being purely a matter of chance. It is assumed that there is no selective mating and that each type of mating is equally fruitful. This point has already been brought out by Hardy in SCIENCE, July 10, 1908, p. 49.

Hybrids of Higher Order

By a process similar to the above it may be shown that when the two types differ in respect of two Mendelian characters, or a single character consisting of two factors, the population tends to assume the following ratios for the various types:

no tendency for the relative numbers of the various zygotic types to change, offers a rational explanation of the rapid development of races having strikingly different characteristics, when a species is first brought under domestication. Let us consider for a moment the condition of the wild species. Amongst our wild gray squirrels are occasionally seen black specimens; also albinos. These varietal characters have originated presumably by the loss, either gradually or in any other manner, of a character formerly possessed. This change may have occurred at any time in the history of the species, or even before the species existed in its present form. There is no tendency, with random mating, for the

TABLE II.

Type formulæ,	*AABB*,	*AABb*,	*AAbb*,	*AaBB*,	*AaBb*,	*Aabb*,	*aaBB*,	*aaBb*,	*aabb*,
" ratios:									
Generation F_0,	a	.	.	.	.	.	.	.	i
" F_1,	a^2	.	.	.	.	.	.	.	i^2
" F_2,	$(a^2+\frac{1}{2}ai)^2$	$a^2i(a+\frac{1}{2}i)$	$\frac{1}{4}a^2i^2$	$a^2i(a+\frac{1}{2}i)$	$a^3i+3a^2i^2+ai^3$	$ai^2(i+\frac{1}{2}a)$	$\frac{1}{4}a^2i^2$	$ai^2(i+\frac{1}{2}a)$	$(i^2+\frac{1}{2}ai)^2$
" F_3,	$(a^2+\frac{1}{4}ai)^2$	$\frac{3}{2}a^3i+\frac{3}{8}a^2i^2$	$\frac{9}{16}a^2i^2$	$\frac{3}{2}a^3i+\frac{3}{8}a^2i^2$	$\frac{1}{2}a^3i+3\frac{1}{4}a^2i^2+\frac{1}{2}ai^3$	$\frac{3}{2}ai^3+\frac{3}{8}a^2i^2$	$\frac{9}{16}a^2i^2$	$\frac{3}{2}ai^3+\frac{3}{8}a^2i^2$	$(i^2+\frac{1}{4}ai)^2$
" F_n,	a^4	$2a^3i$	a^2i^2	$2a^3i$	$4a^2i^2$	$2ai^3$	a^2i^2	$2ai^3$	i^4

That is, the proportions of the various types tend to assume the relative numbers shown in the last line of the above table, and thereafter there is no tendency for these ratios to change. It is interesting to note that the terms of the last line of table II. may be obtained from those of the last line of table I. by multiplying by $a^2+2ai+i^2$ (= the square of $a+i$); thus, multiplying a^2 the first term in the last line of table I., by $a^2+2ai+i^2$, gives the first three terms of the last line of table II.

If the original population consists of two types which differ in respect of three Mendelian characters, the ratios of the twenty-seven resulting types in the final population may be obtained from the last line of table II., as that was from the last line of table I.

The fact that in such a mixed population, with no selectional mating, and with equal fruitfulness of the various matings, there is

new characters to spread through the species. In fact, there is probably a tendency toward their elimination by natural selection. Such a tendency, however, would operate very slowly in the case of a recessive character, which is transmitted unseen in far more individuals than those showing it (under the conditions assumed). It is entirely possible that all the varietal variations which are possible to this species actually exist in the wild species, each in exceedingly small proportions, because it has originated in a very small fraction of the species, and does not tend to spread over the species unless favored by natural selection. Should the species be domesticated, the art of the breeder, who would naturally be attracted by new types that crop out (which occurs when heterozygotes are mated) would seize these forms and establish races from them.

It is a fact noted by many investigators, and especially insisted on by de Vries, that most races of domesticated species are derived from the wild form by the loss of one or more hereditary characters. That these race peculiarities are, generally speaking, recessive to the wild form is well established, and the reason therefore is apparently clear. But that these peculiarities may have originated ages ago in the wild form, and been transmitted almost unnoticed, has not hitherto been suggested. We have seen above that such may be the case. Furthermore, peculiarities that may have had indefinite time in which to develop are not greatly in need of a theory of "saltatory change" to explain their abundant development in domesticated species.

W. J. Spillman
U. S. Department of Agriculture

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION B—PHYSICS

The summer meeting of the American Association for the Advancement of Science, Section B, was held in the Wilder Laboratory of Dartmouth College, Hanover, N. H., June 30, 1908. This was a joint meeting with the American Physical Society. There were two sessions, one in the forenoon and one in the afternoon. The attendance at each was about seventy. Professor Edward L. Nichols, president of the American Physical Society and president last year of the American Association for the Advancement of Science, was the presiding officer.

The titles and abstracts of the sixteen papers presented are given below:

Light Pressure on Black Surfaces and on Thin Plates of Glass (with experimental demonstration): G. F. Hull, Dartmouth College.

Some years ago E. F. Nichols and Hull proved the existence experimentally of a pressure due to light upon a silvered glass surface. Maxwell had proved theoretically that such a pressure exists.

By Larmor's theory, however, the pressure on a glass surface should be zero. Professor Hull showed experiments which do not justify Larmor's conclusion. He exhibited an apparatus in action which showed the comparative effects obtained by allowing radiation of the same intensity to fall successively upon four kinds of surface. The results of such a comparison show the pressures to be as follows:

	Deflection
1 glass vane	1.0
2 glass vanes	1.7
Enclosed black vane	5.6
Silvered vane	11.5

These results indicate that Larmor's conclusion is incorrect. Maxwell's formula gives results quantitatively agreeing with the above measurements. For example, the values indicated for the above four cases by applying Maxwell's formula are 1.0, 1.83, 5.86 and 11.2, respectively.

(At the conclusion of the paper the president of the Physical Society, who was presiding, congratulated the section that all its members had been able to see for themselves an effect due to a force so small that the possibility of showing its actual existence had not been hoped for by eminent physicists until a very few years ago.)

Changes in Density of the Ether, and Some Optical Effects produced by it: Charles F. Brush, Cleveland.

This paper described two series of careful experiments, conducted on different lines, the results of which afford strong evidence in support of the following hypotheses:

1. The ether passes slowly, and *not* freely, through glass and presumably through other bodies.

2. The ether is susceptible of change in density. It may be dilated and presumably compressed in a glass vessel, the phenomenon lasting long enough to be observed with ease.

3. While dilation of the ether does not alter materially, if at all, the velocity of the light waves in it, it does reduce the amplitude or energy-carrying capacity of both long and short waves, *i. e.*, of low heat and actinic radiation.

The apparatus and experiments were fully described by means of a fine set of lantern slides, many of which showed photographic effects obtained during the experiments themselves.

On Oscillations in the Metallic Arc: W. G. Cady, Wesleyan University.

Two types of oscillations occurring in an electric arc light were considered. The first are produced in the iron arc in free air, with a frequency of about 1,500 per second. These seem to be mechanical and were dismissed with brief comment. The second type was considered more at length. They are of much higher frequency and occur with electrodes of various substances,

but best when one electrode is either copper or silver, the arc burning in illuminating gas. The oscillations are most intense with high voltage and a current between one ampere and the point at which the arc changes to a glow. To gain an idea of the maximum potential difference across the arc during one cycle an apparatus for obtaining a point discharge in hydrogen was connected in parallel with the arc. The results indicate that the effect is an exceedingly rapid change back and forth between arc and glow discharge, of a frequency of something like a million per second. Experiments were described on the use of a resonating circuit near the arc, and on the connection of a capacity and self-inductance across the arc.

A Study of Overcast Skies: EDWARD L. NICHOLS, Cornell University.

The spectrophotometric measurements which formed the basis of this paper were carried out by means of a portable apparatus which could readily be set up during the travels of the author in Europe, and gave the opportunity to compare the skies of widely different localities and different times of day. The relative intensities of the different color-components were very different with different kinds of sky. The radiation was scarcely ever selective but almost always of the "black body" type. There is, however, almost always an absorption band in the violet during the middle of a bright day in mountainous regions. Its development is coincident with the gathering of a slight mist.

The illumination from an unclouded sky is about the same as from a completely clouded sky. More light comes, however, from a sky which is partly covered with clouds than from either. The so-called "cumulus" clouds produce especially good luminosity.

Demonstration of Wilson's Cloud Experiment, etc.: G. F. HULL, Dartmouth College.

This consisted of a demonstration of several improved forms of lecture experiments, as follows:

1. A very simple and satisfactory form of Wilson's "cloud" experiment, showing the conditions under which the cloud is obtained.

2. Wehnelt's tube, in which electrons sent out by a "button" of calcium compound in an exhausted tube were shown experimentally to be present.

3. An improvement on Mayer's floating magnet experiment, consisting of passing a single turn of wire around the circular glass vessel, in which the small vertical magnets are made to float. By sending current through this wire the effect of surface tension at the boundary is entirely eliminated. The stable configurations of magnets are different from those secured when a central control magnet is used. But the fields due to the current and to a central magnet are easily superposed.

Interest in the floating magnet experiment has been recently revived by J. J. Thomson's theories regarding the structure of atoms.

The Influence of Temperature on the Fluorescence of Uranium Glass: R. C. GIBBS, Cornell University.

The glass used was a block of canary glass. The light from a mercury arc was sent through this glass, whose temperature was changed in a measurable way through about 400 degrees Centigrade. Results will be published in the *Physical Review.*

Some Electrical Properties of Silicon: FRANCES G. WICK, Cornell University.

The silicon used was made at Niagara Falls. The following properties were noted:

1. In its resistance it was found to change with temperature as carbon does and not as the metals.

2. The thermo-electric power with respect to lead was found to be 220, which is larger than for any other substances except selenium and tellurium.

3. It was found also that, as with selenium and tellurium, the Hall effect was large in silicon.

4. Rods of the element were used as one element in voltaic cells, but without developing any special promise of usefulness as compared with copper, etc. In its position in the electromotive series it is very near copper.

A Study of Short-time Phosphorescence: C. W. WAGGENER, Cornell University.

All good measurements since the time of Becquerel show about the same kind of luminosity-decay curve. The recent work which forms the basis of this paper was designed to see if this form is characteristic of substances which lose their luminosity in an exceedingly short interval, say within one seven-hundredth of a second. The apparatus used was that devised by Nichols and Merritt a year or two ago. It was found that practically the same form of decay curve characterizes substances of this class as those whose period of decay is longer.

An Experimental Study of the Recovery of Selenium Cells: L. S. MCDOWELL, Cornell University. (Read by title.)

A Comparative Investigation of Dispersion and Electric Double Refraction in Liquids: H. E. McComb, University of Nebraska. (Presented by Professor C. A. Skinner.)

This study showed in general that the change in refractive index follows the same law as that of the constant of electric double refraction. Six liquids were studied. Five of them showed this agreement, but one (di-methyl-aniline) showed no definite relation between the two constants.

Electromagnetic Mass and Energy: Daniel F. Comstock, Massachusetts Institute of Technology. (Read by title.)

Effects of Absorbed Hydrogen and of Other Gases on the Photoelectric Activity of Metals: V. L. Chrisler, University of Nebraska. (Presented by Professor C. A. Skinner.)

Following the method used by Holman (*Phys. Rev.*, August, 1907) the effect upon its photo-electric activity of using a metal as cathode and as anode in a glow current, has been investigated. The effect of surrounding it by different gases has also been tested.

Using fourteen different metals, they showed, without exception, a decreased photo-electric current by continued use as a cathode surrounded by hydrogen. On the contrary, when used for a moment as an anode surrounded by the same gas they showed a marked increase in activity. With some metals the photo-electric current was thirty times as great after using as anode as after use as cathode. This effect was obtained with conducting hydrogen; exposure to non-conducting hydrogen increases the activity, but much less rapidly.

The activity of the metals practically vanished after extended use in either helium or oxygen, nor could any trace of recovery be obtained by use as anode in the same gases. In nitrogen use as cathode did not wholly destroy the activity; with silver alone an increase was obtained by use as anode, slight but definite. Carbon was like silver in this respect.

When the activity had been reduced to a vanishing quantity by use in other gases, it was readily regained by introducing an atmosphere of hydrogen. A gradual disappearance of hydrogen accompanied this increase in activity. After use as cathode in hydrogen, the metal became negatively charged; after use as an anode it was positively charged. These results are readily explained if hydrogen on being absorbed or given off by the metal, carries with it a charge of negative electricity. Whether immediately or indirectly, hydrogen appears to be the prime agent in rendering metals photo-active.

A New Method for Determining the Difference of Potential between a Metal and a Solution of One of its Solids: A. W. Ewell, Worcester Polytechnic Institute.

The experiments of Ayrton and Perry on this subject were repeated with some modifications. A glass vessel was covered with tinfoil which was connected to the needle of a Dolezalek electrometer. Its terminals were connected to those of a 40-cell battery, earthed at the center. A metal electrode placed in a solution of one of its salts was also earthed. One volt gave a deflection of 8 cm. Copper in copper sulphate solution, zinc in zinc sulphate and mercury in potassium chloride were used in the measurements.

The Isothermal Layer of the Atmosphere: W. J. Humphreys, Mt. Weather Meteorological Observatory.

The temperature of the atmosphere decreases more or less uniformly with increase in elevation above the surface of the earth until an elevation of from 30,000 to 60,000 feet is reached, where the temperature is $-50°$ to $-60°$ C. From this elevation up as far as balloons have gone the temperature remains practically constant. This is explained as the result of radiation, mainly from the moisture in the air, which will have an effective radiating surface of great extent in comparison with elevations reached by balloons. The means of locating this surface was considered. The relative proportion of the different constituents of the air is different at different elevations, the proportion of water vapor being relatively great in the lower layers. Calculation shows the temperature of this "effective radiating surface" to be about $-33°$ C. (The calculations were carried through in detail before the joint session.)

Coefficients of Expansion at Low Temperatures: H. G. Dorsey, Cornell University.

Curves were drawn with temperature and expansion as coordinates. Temperatures used ranged from 113° C. (absol.) to 213°, and were secured by the use of liquid air. Selenium and hard rubber gave nearly a straight line, while zinc and gold gave very irregular curves. A second sample of gold of greater purity (obtained from the U. S. mint) gave a straight line. Fiber cut in three different directions with respect to the direction of its grain, was also used.

The full paper is published in the July number of the *Physical Review.*

A. D. Cole,
Secretary Section B.